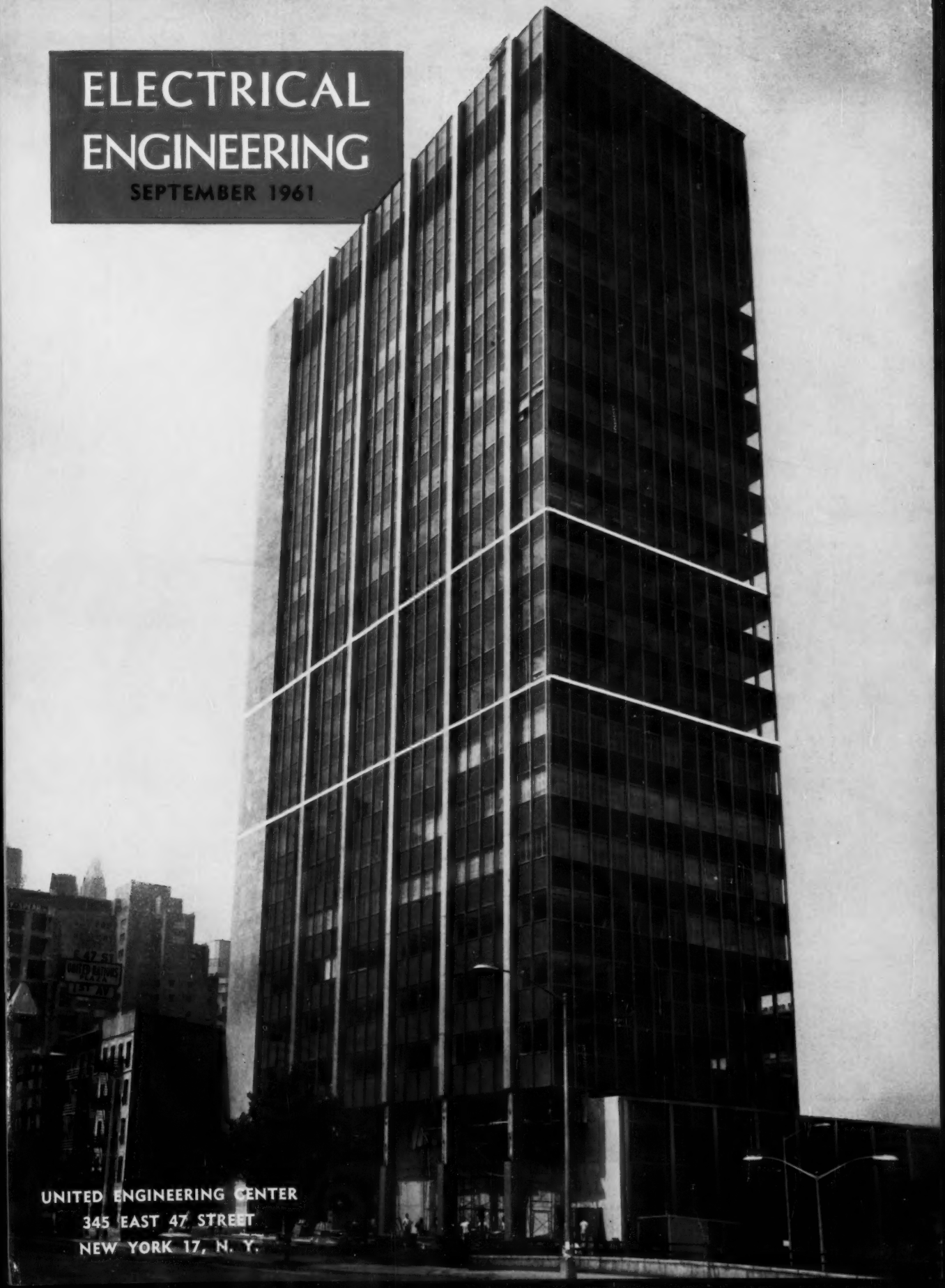
ELECTRICAL ENGINEERING

SEPTEMBER 1961



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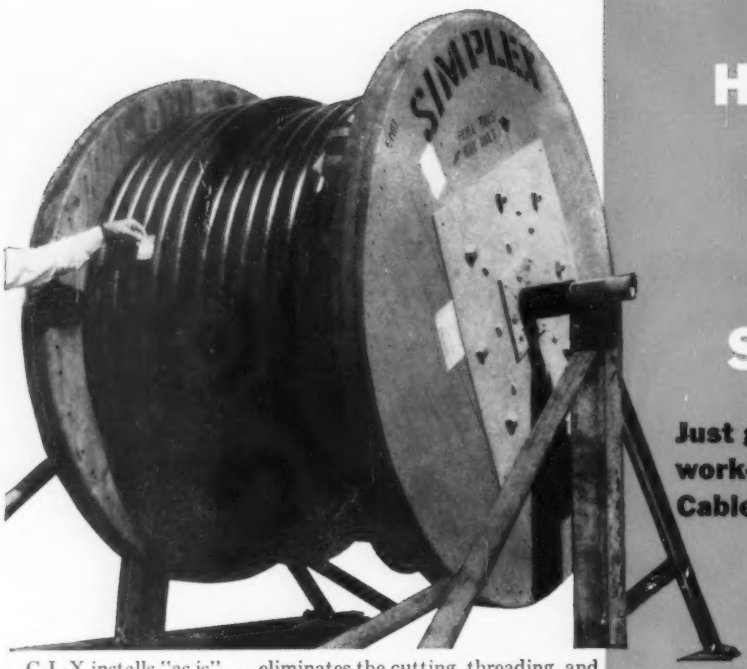

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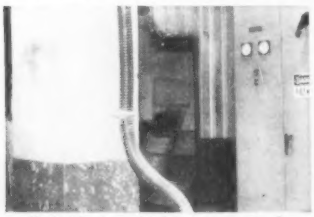

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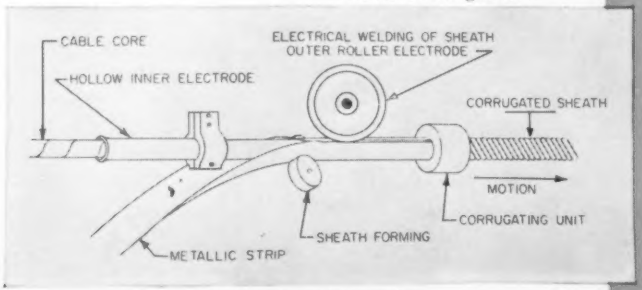

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ELECTRICAL ENGINEERING

SEPTEMBER 1961
Vol. 80, No. 9

THE COVER: The AIEE will move from the 55-year-old building on 39th Street in New York to the new United Engineering Center. The new address will be 345 East 47 Street, New York 17, N.Y., as of September 5, 1961. The Institute will occupy the ninth, tenth, and eleventh floors of the new building, as indicated by the white outlines on the cover photograph, which was made in late July. The United Engineering Center fronts on United Nations Plaza and extends westward along 47th and 48th Streets.

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NUMBER 18—NEW PRODUCT SERIES

Here is military reliability in a competitively-priced industrial potentiometer. Bourns wirewound 10-turn Model 3500 measures just ⅞" in diameter by 1" long—shorter by ½" than units available elsewhere—yet has a resistance element 20% longer than that of comparable potentiometers.

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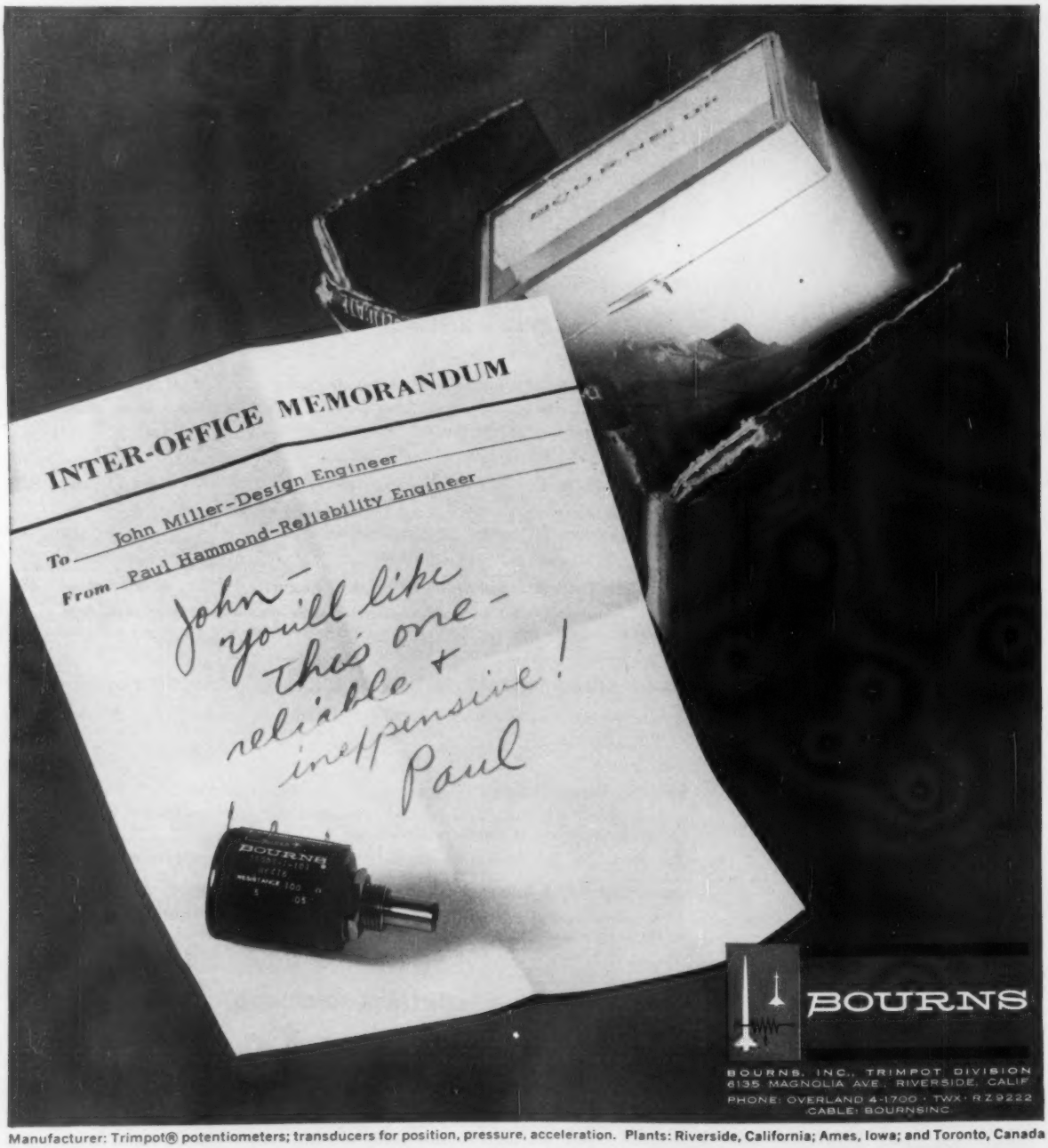

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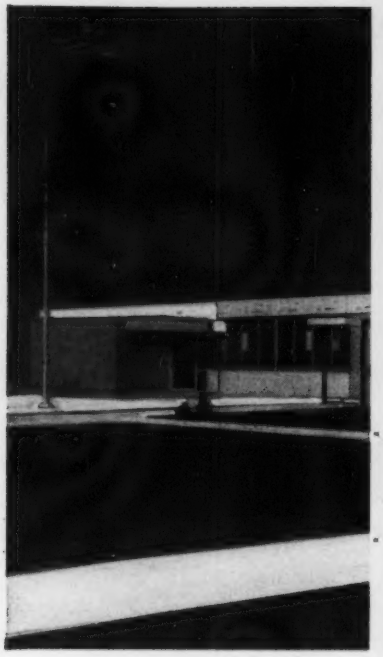

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The complete use of electrical energy puts special emphasis on the need to use the safest, most modern protective devices throughout the electrical system.

In each school, the main switchboard is protected by 3—1600 ampere BUSS Hi-Cap fuses having an interrupting rating of 200,000 amps. rms symmetrical. Thus, safe interruption of fault currents now available is assured,—and the fuses are adequately safe to allow for future system growth.

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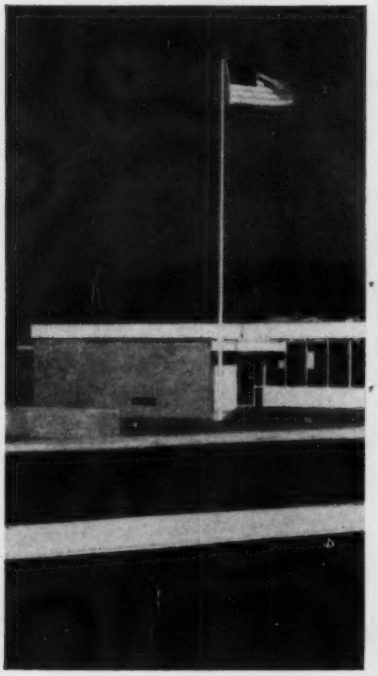

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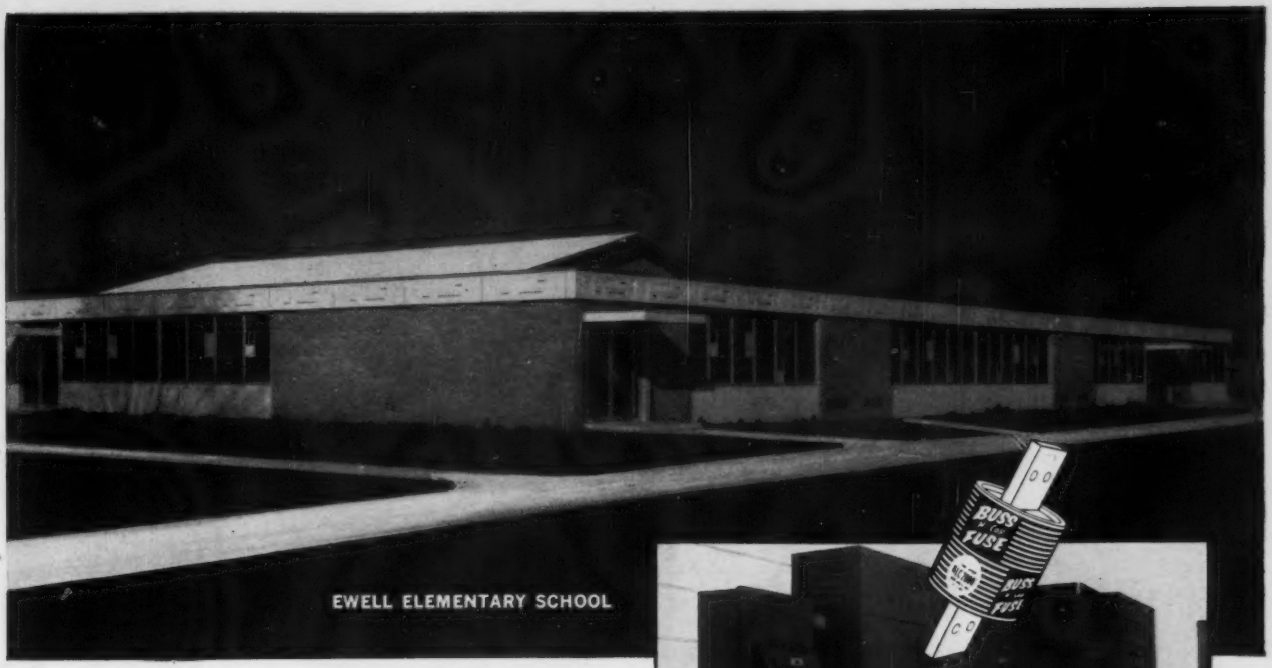

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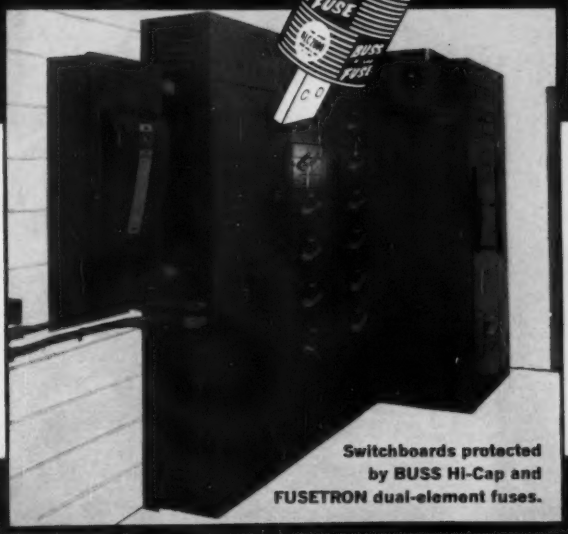

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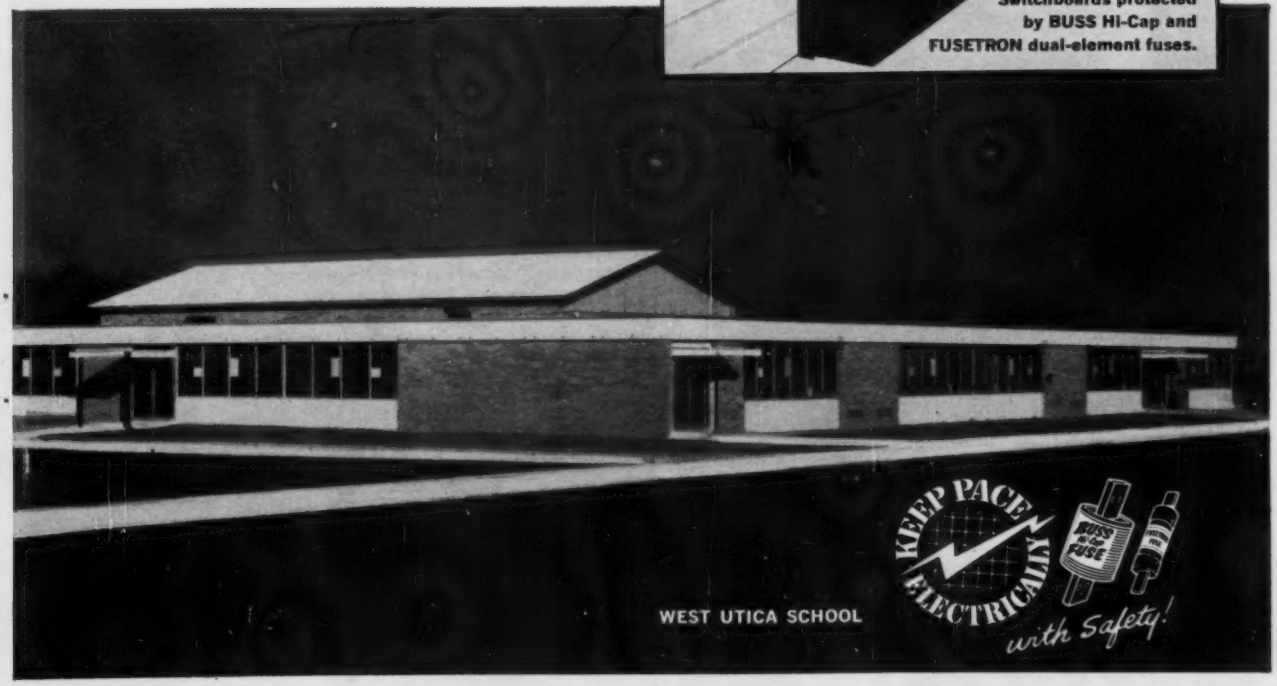

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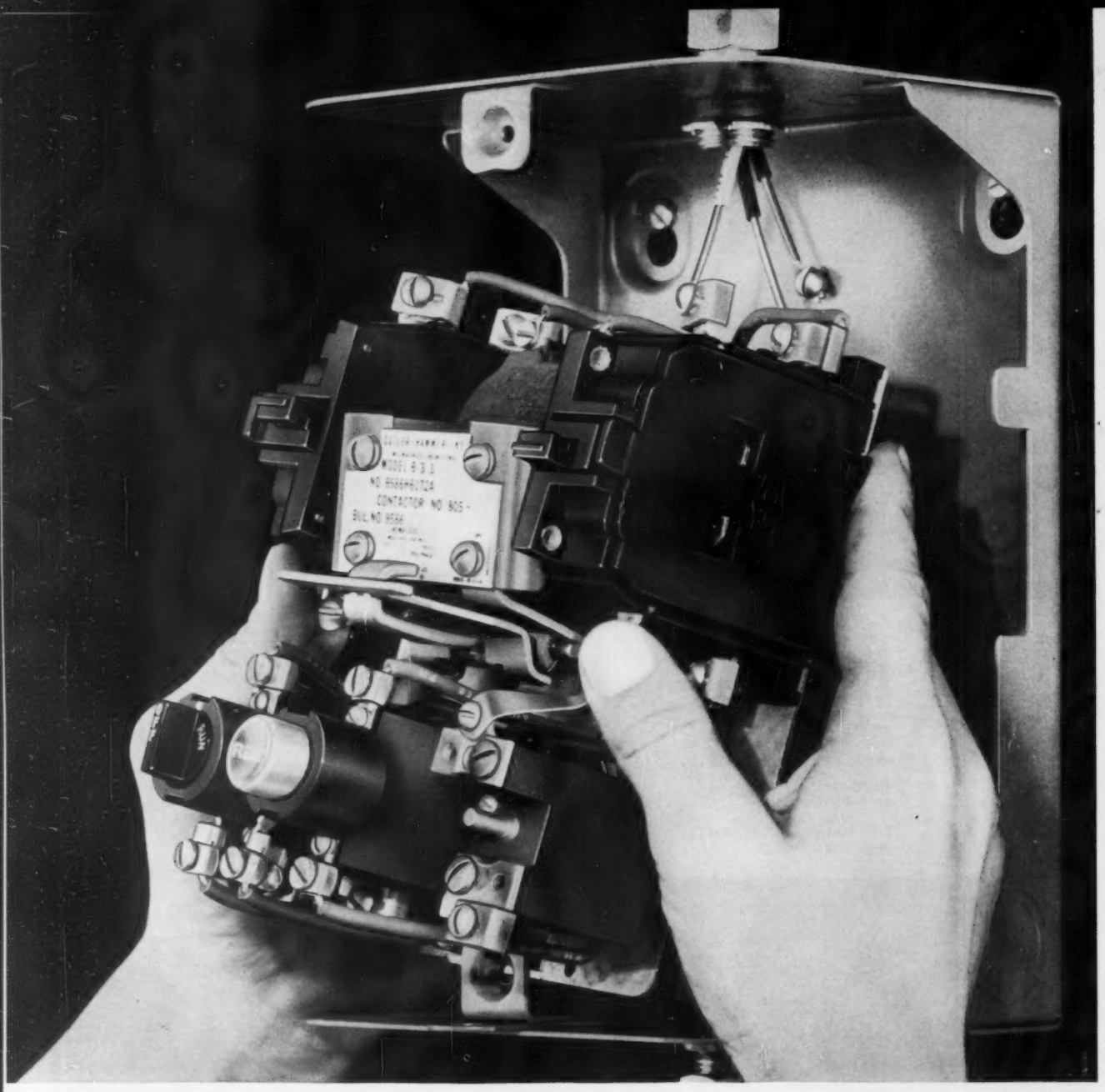

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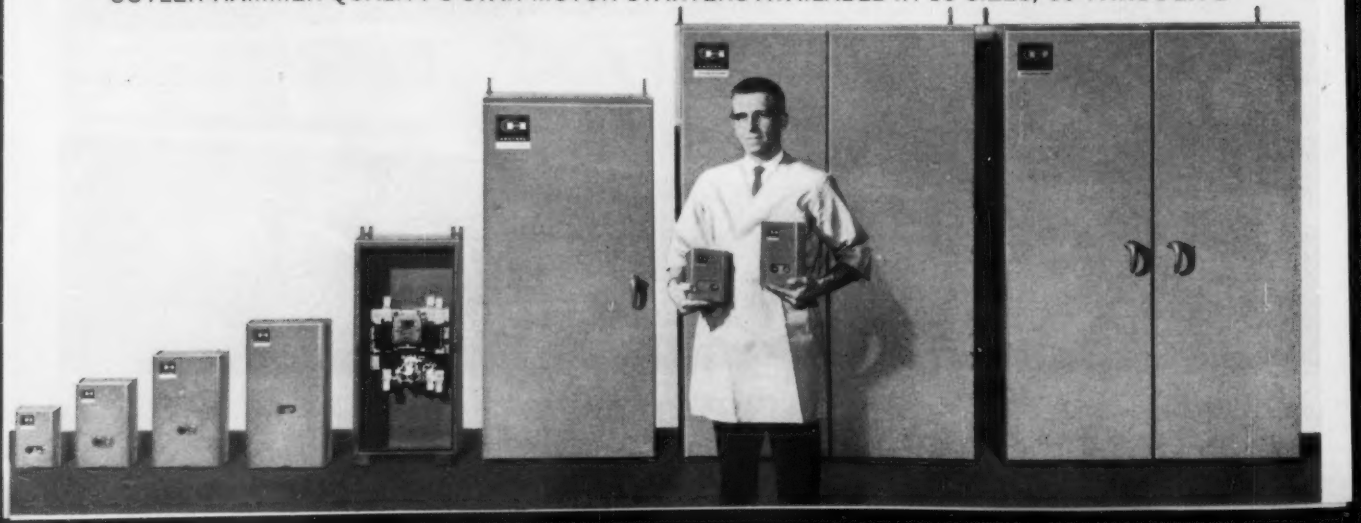

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Millions of satisfactory operations in thousands of applications have proved the unmatched quality of Cutler-Hammer across-the-line magnetic starters. That this line is still recognized as the leader—nine years after the original design was developed—is a great tribute to the years-ahead thinking of Cutler-Hammer engineers.

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If you're one of many companies being forced to stock two sets of parts because of design changes, now is an excellent time to standardize on Cutler-Hammer.

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New and Improved Products . . .

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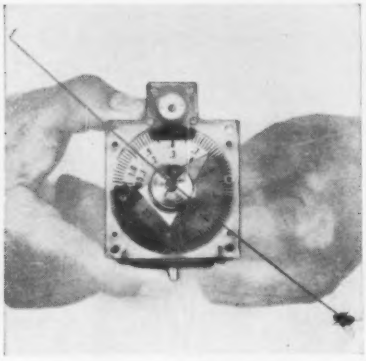
Comparison of relative torque values of ball bearings can be accomplished economically with a new low-range, direct-reading Torqmeter. Full-scale ranges for the instrument are 1,



2, and 5 gram-centimeters. Static and slow torques are read directly. Torques over 10 rpm are read with the aid of a strobe light synchronized with the dial by a voltage "pip" coil mounted on the instrument. *Power Instruments, Inc., 7352 N. Lawndale Ave., Skokie, Ill.*

Cable and Harness Tester . . .

Rapid and simultaneous continuity and breakdown testing of as many as 17 conductors in a planned sequence is possible with the series *701* cable and harness tester. The new unit makes continuity tests at a maximum current of 500 ma. Acceptance limit is adjustable between 1 and 5 ohms. Breakdown test voltages of 500, 1,000, 1,250, 1,500, 2,000, and 2,500 are available. Units are quickly programmed by simple adjustment of built-in program switches and may be used singly, or in banks for the testing of cables, harnesses, circuit boards, relays, switch panels and the like. *Slaughter Co., Piqua, Ohio.*

Gas Cell Clock . . .

A timepiece that provides a stable frequency source comparable to a clock that varies only one second in 300 years operates on a virtually indestructible gas cell and uses little power. Frequency is activated when a light beam is passed through the gas cell to provide a difference in the energy states of the atoms of rubidium. Transition from one state to another provides the microwave reference on which the device depends for its stability and function as a time-measuring instrument. *FMA, Inc., El Segundo, Calif.*

1,000-Fahrenheit Wire . . .

Motors that run while they glow in the dark and relays that function properly in the heart of a flame are among the several extreme-heat applications made possible with this latest development. Reliable and practical, the new ceramic insulated flexible magnet wire will withstand heated areas of 1,000 degrees F. *General Cable Corp., 730 Third Ave., New York 17, N. Y.*

Synchronous Timer Motor . . .

A new method of sealing all moving parts in oil to achieve noiseless and virtually life-time continuous operation is effected by a specially designed spring-loaded packing gland that prevents oil from working out of the housing. Key element of the packing gland is a neoprene O-ring held under constant pressure by a spring. *Controls Co. of America, 110 West Woodstock, Crystal Lake, Ill.*

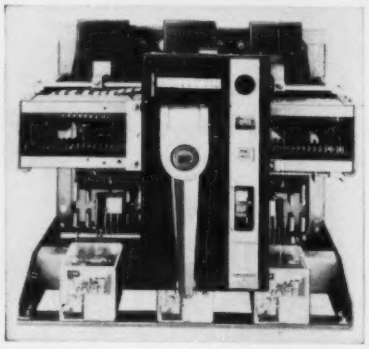
Miniature TV Camera . . .

Only 9 inches long and less than 3 inches in diameter, a new closed-circuit television camera is now available. The Minicamera is small enough to scan the interior of a 3-inch pipe. The camera will operate without special protection in environments where there is considerable noise or vibration. The casing is strongly built to withstand heavy industrial use; it does not require ventilation holes and is therefore protected against dust. Re-

mote-control facilities for zoom lens, focus, iris, pan and tilt and a full range of accessories are available. *Fairbanks, Morse & Co., 100 Electra Lane, E. Station, Yonkers, N. Y.*

Power Circuit Breakers . . .

Higher interrupting capacities and continuous-current ratings of the new FP line of power circuit breakers offer increased economy and dependability. The new line is divided into two



groups: the *FP-50* series consists of three increased frame-size breakers based on continuous current ratings of 400, 800, and 2,000 amperes with 50,000-amp asymmetrical interrupting capacity at 600 vac. The *FP-100* series offers two frame sizes with 100,000-amp asymmetrical interrupting capacity in continuous-current ratings of 3,000, and 4,000 amp at 600 vac. A new fast-acting stored-energy mechanism insures constant quick make of breaker contacts. Other features include easy field adjustment of the series trip coil and magnet assembly and the TD timing device; long-life contacts; versatile enclosures; telescoping rollout and an integral flush-mounted power hoist. *Federal Pacific Electric Co., 50 Paris St., Newark, N. J.*

Ground Detector and Alarm . . .

Immediate detection of accidental grounds on power lines is provided by a new ground detector and alarm. When the instrument is wired to a power system, 3-phase indicator lamps on the face glow with equal intensity. As a ground occurs, one of the lamps dims or goes out, indicating on which phase the ground has occurred. Simultaneously a red warning lamp flashes steadily and a relay actuates an audible signal connected to the instrument. The warning flash and audible signal continue until a reset button is pushed. The red lamp glows until the ground is cleared. The 3-phase indicator lamps then resume their normal uniform brightness. *Parr Mfg. Corp., 40 Austin St., Newark, N. J.*

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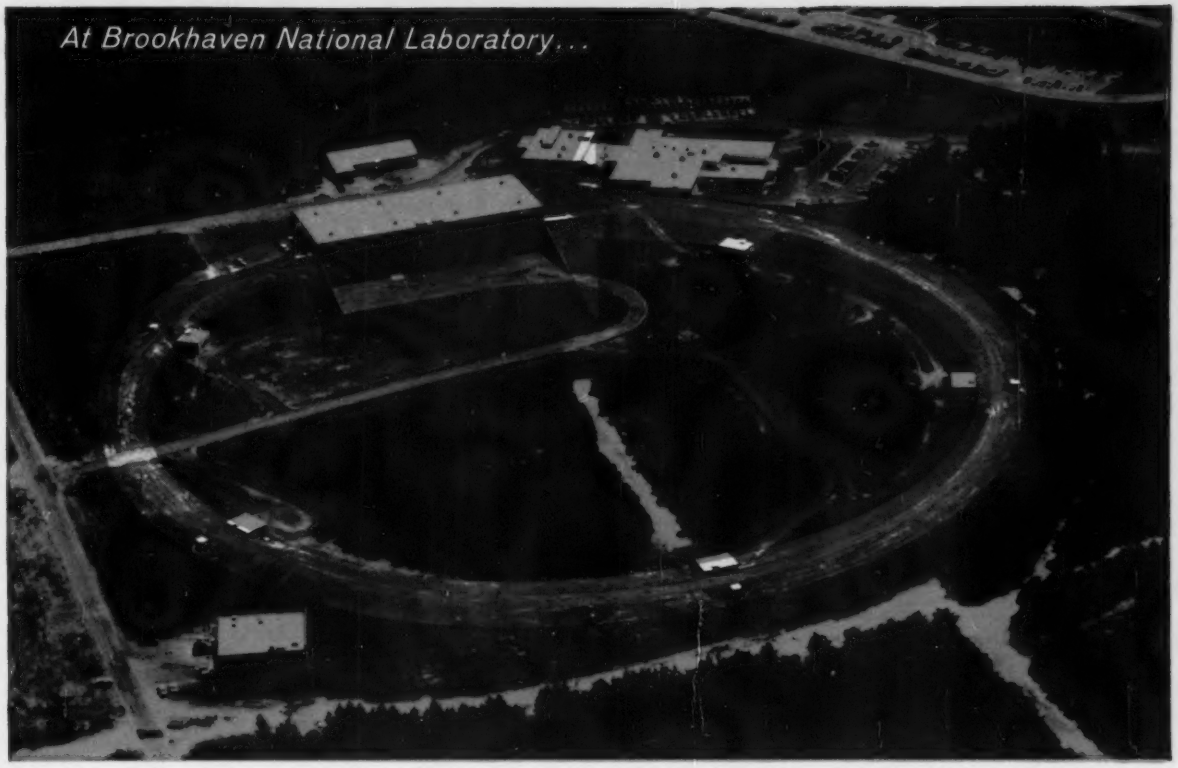

30 Billion Atom-Smashing Volts Keep On Target With Help Of A Sel-Rex Rectifier!

Promising to unlock the innermost secrets of the atom, the world's largest high-voltage proton accelerator circles underground—hidden from the casual observer beneath ten feet of earth and a carpet of new grass.

Named the Alternating Gradient Synchrotron, or AGS, the high voltage atom smasher is the pride of the famous Brookhaven National Laboratory, Upton, N. Y., home of many major achievements in atomic research.

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At the end of the high speed run, its protons are traveling at close to the speed of light. This surging force of 30 Billion Electron Volts, directed into a target building, is used experimentally to learn further secrets of the atom . . . to find new particles of matter.

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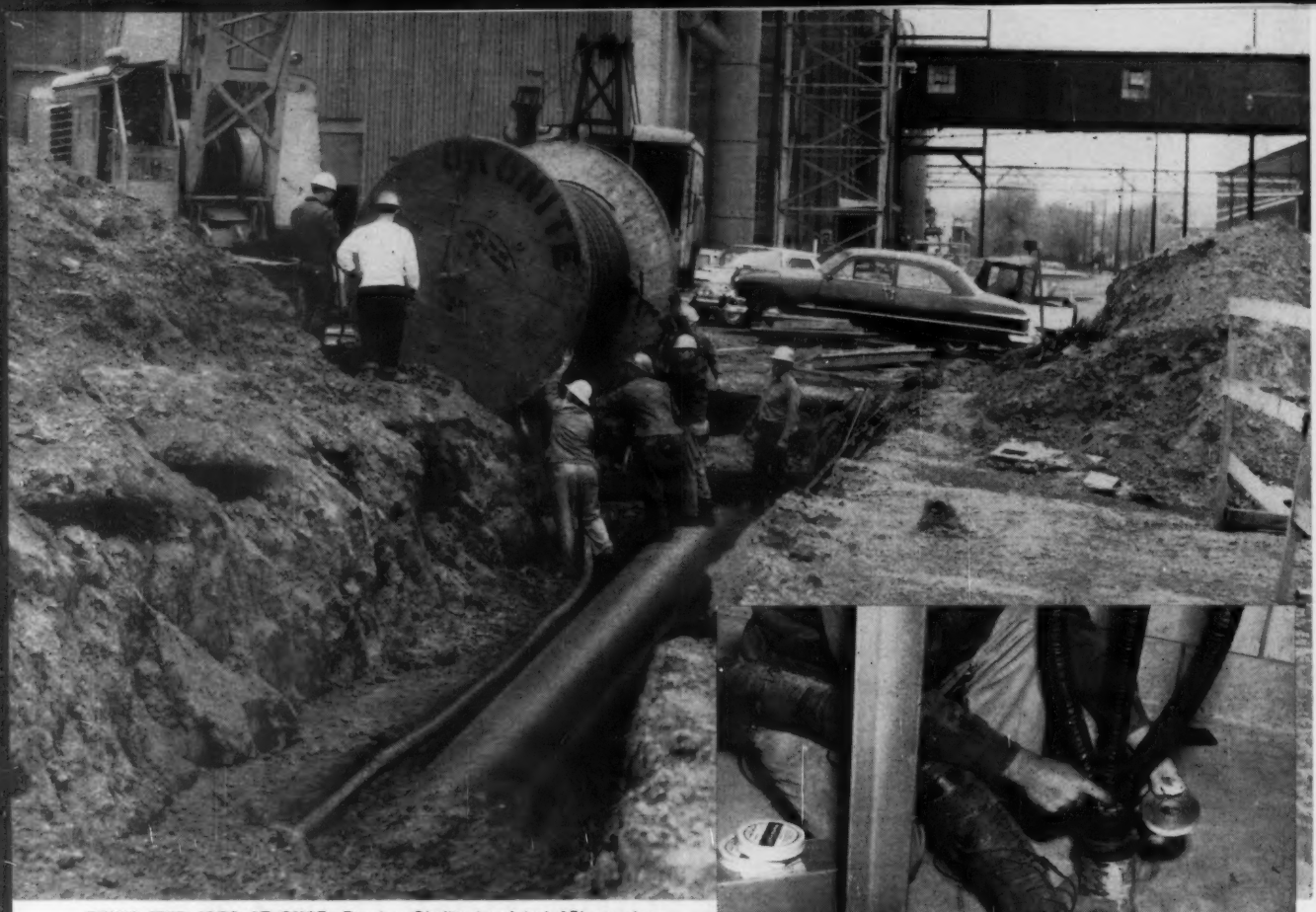
Representatives in principal cities.

Complete Semi-Conductor Power Conversion Equipment and Systems for any AC to DC Application



DOING TWO JOBS AT ONCE—Burying Okolite insulated 15kv underground cable at the same time water pipes were laid,cut installation cost for The Mead Corporation. Naturally, cable failure can not be tolerated once this system is completed.

THE FINAL QUALITY TOUCH—Using Okonite "Cable-Matched" tape . . . a workman completes the job at the termination. Okonite quality splicing materials make splices and terminations as reliable as the cable.

THE MEAD CORPORATION USES OKOLITE CABLE FOR...

The MAXIMUM in circuit security
The MINIMUM in long-term cost

The Mead Corporation, one of the world's largest paper manufacturers, has used Okolite insulated cables for many years. The expanding Okolite cable system at their main mill in Chillicothe, Ohio opens the way to greater production capacities to handle an increasing market demand for Mead paper products.

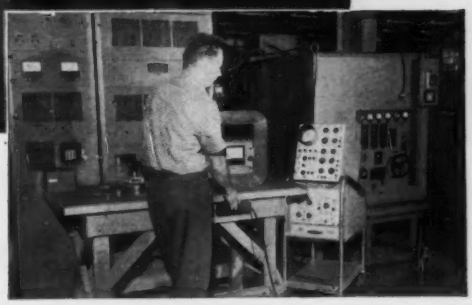
There are many unique factors about the Chillicothe mill. To begin with, the plant is completely dependent on well water for its operation. Any failure in the pumping equipment means an immediate shutdown. To secure the maximum in circuit security and to obtain installation economies, the cable was buried at the same time new water pipes were being laid. Okolite-insulated cables—a 15kv cable for a 2½ mile main circuit and 5kv Okolite cable for two feeders linking transformers and pumping stations—helps to assure the trouble-free service so necessary for Mead.

The Okolite insulated cables installed at Mead were manufactured by the strip process to guarantee perfectly centered conductors and years of optimum circuit security. Find out what Okonite Cable'bility* can mean in reducing the long-term cost of your own vital installations. For complete details write for Bulletin EG-1085, The Okonite Company, Subsidiary of Kennecott Copper Corporation, Passaic, N. J.

*Cable'ability . . . cable craftsmanship since 1878

***where there's electrical power . . . there's* OKONITE CABLE**

8379

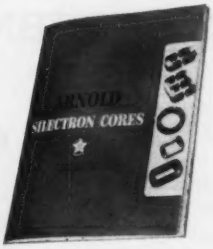


7372D

Arnold Pulse Transformer Cores are individually tested under actual pulse conditions

Here's technical data on

ARNOLD SILECTRON CORES



Bulletin SC-107 A . . . this newly-reprinted 52-page bulletin contains design information on Arnold Tape Cores wound from Silectron (grain-oriented silicon steel). It includes data on cut C and E cores, and uncut toroids and rectangular shapes. Sizes range from a fraction of an ounce to more than a hundred pounds, in standard tape thicknesses of 1, 2, 4 and 12 mils.

Cores are listed in the order of their power-handling capacity, to permit easier selection to fit your requirements, and curves showing the effect of impregnation on core material properties are included. A valuable addition to your engineering files—*write for your copy today.*

ADDRESS DEPT. EL-9

The inset photograph above illustrates a special Arnold advantage: a 10-megawatt pulse-testing installation which enables us to test-prove pulse cores to an extent unequalled elsewhere in the industry.

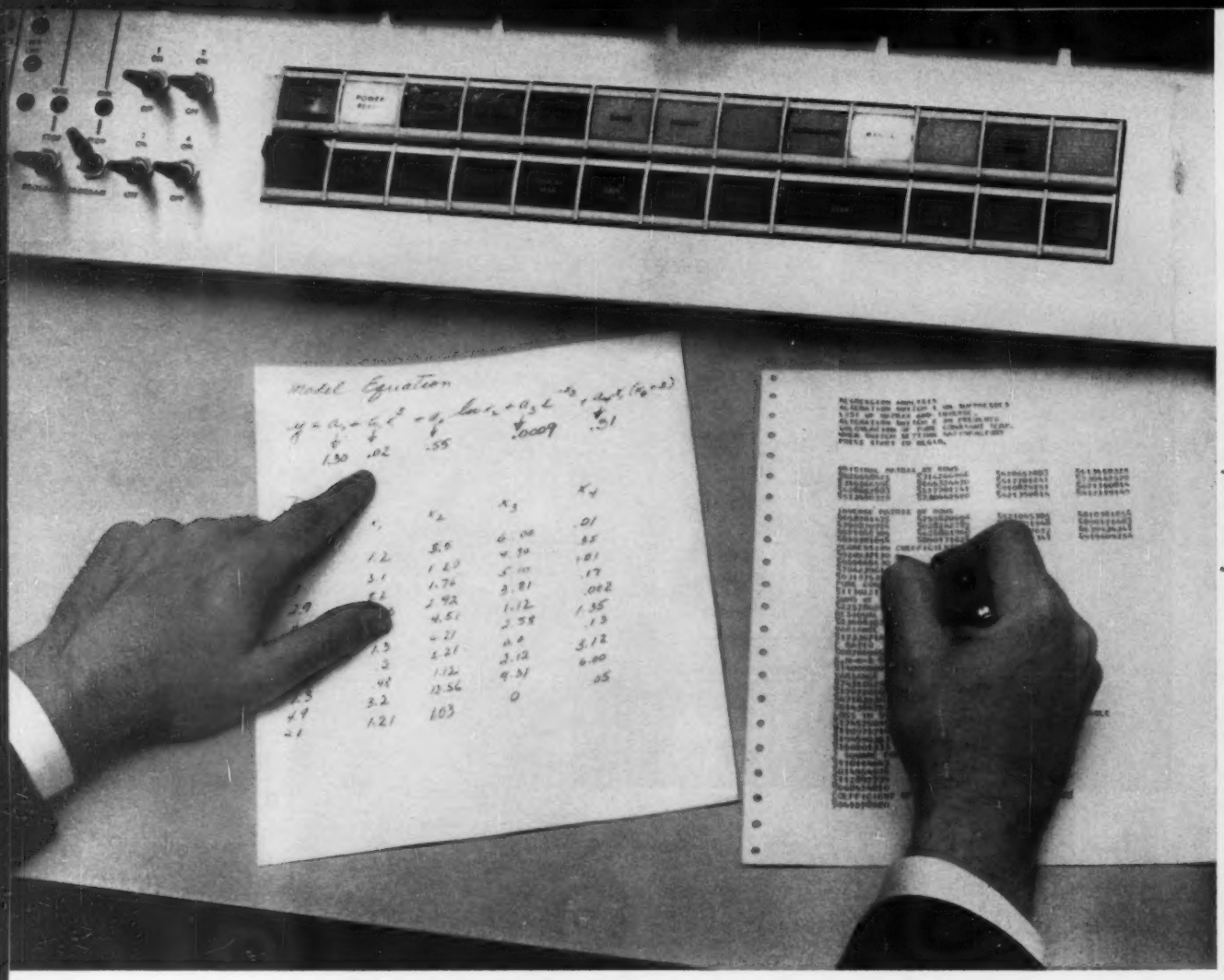
For example, Arnold 1 mil Silectron "C" cores—supplied with a guaranteed minimum pulse permeability of 300—are tested at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gausses. The 2 mil cores, with a guaranteed minimum pulse permeability of 600, receive standard tests at 2 microseconds, 400 pulses per second, at a peak flux density of 10,000 gausses.

The test equipment has a variable range which may enable us to make special tests duplicating the actual operating conditions of the transformer. The pulser permits tests at .05, .25, 2.0 and 10.0 microsecond pulse duration, at repetition rates varying anywhere from 50 to 1000 pulses per second.

This is just another of Arnold's facilities for better service on magnetic materials of all description. ● Let us supply *your* requirements. *The Arnold Engineering Company, Main Office & Plant, Marengo, Ill.*

ARNOLD
SPECIALISTS In MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES
Find them FAST in the YELLOW PAGES



Want to find the coefficients? It's easy with the new Regression Analysis program for the IBM 1620

Here's another program offered free-of-charge to users of the IBM 1620 Data Processing System. It gives you the kind of results you might expect only from a much more expensive computer. But users of the 1620 know that its low rental cost is deceptive. The 1620 packs *more computing power per cubic inch* than any other computer in its size range.

The Regression Analysis program is a good example. Suppose you want a fit for production purposes. If you employ more than two variables you probably have difficulty visualizing the representation of your data. If linearity is not the case, you must often guess blindly at a polynomial of high degree, accept or reject the fit with something approaching a sixth sense, and either try again or settle for the results you have.

The new Regression Analysis program lets you handle expressions containing up to *24 variables*. If you have the even more complicated task of handling many dependent variables, the program will generate regression coefficients with a maximum number of dependent variables not exceeding one-half the number of independent variables.

This program will also fit non-linear functions and hyper-surfaces. Compare this performance with that of any other computer in the 1620's price range.

A basic 1620 installation rents for just $1600 per month. For details, contact your local IBM Representative.

IBM's 1620 is a compact desk-size computer.

IBM®
DATA PROCESSING

Anaconda Strip-copper coils cut size and weight

Strip-copper coils cut the size and weight of electrical equipment ranging from watt-hour meters using relatively small coils to pole-mounted distribution transformers rated up to 500 Kva. In many instances operating characteristics can be improved as well.

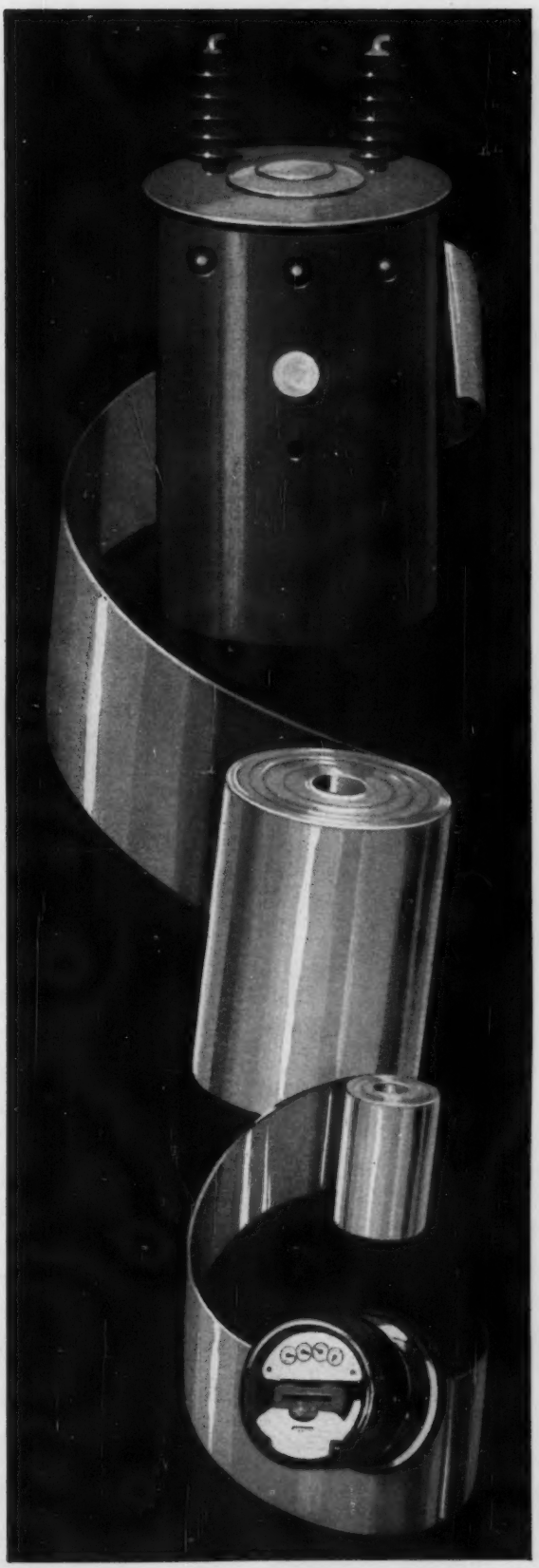
Anaconda is now supplying high-quality copper strip for such uses. The quality of the copper has been extended to the finish, the edge, the packaging and handling. It is deburred, carefully packaged to prevent edge damage, and made available in a wide range of thicknesses and widths to satisfy all needs.

Whatever your use of coils, whatever size and capacity you wind, Anaconda copper strip promises economies in size and weight.

Technical Assistance in the application of Anaconda strip copper to your coil design problems is available from the Metallurgical Dept. Address: Anaconda American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

61-915

ANACONDA®
AMERICAN BRASS COMPANY



When You First Put It Up...

Any 6M Strand will

support 6,000 lbs...

TIME BRINGS OUT THE DIFFERENCE

RUSTABLE STRAND GETS WEAKER— ALUMOWELD STRAND KEEPS ITS STRENGTH

When you buy strand you want the strength you specify—and you want that strength to last. So why waste good money on ordinary strand that can't resist corrosion—that starts to rust away and weaken *after* you install it. Unlike rustable strand, Alumoweld's initial strength remains permanent year after year.

With its *thick* covering of aluminum—25% by area—permanently welded to a strong steel core, Alumoweld gives you the same high resistance to corrosion as solid aluminum. It's made by the exclusive atomic-welding process in which the ductile weld remains permanent under all operating conditions. Corrosive elements can't reach the steel core because of the durable protection of the *thick* aluminum covering.

Diameter for diameter, Alumoweld Strand has the same strength as extra-high-tensile steel—yet, it weighs less and is easier to install. Its initial cost is surprisingly low. In fact, because it will stay up far longer, Alumoweld Strand will actually *cost less* as the years go by.

Alumoweld Strand gives you performance where it counts—on the job! Send for Engineering Bulletin E. D. 3000 and get the full story on Alumoweld's important, money-saving advantages. You'll see why Alumoweld Strand is preferred by so many efficiency-minded, cost-conscious companies.

Supplies of Alumoweld Strand are available for immediate shipment from our warehouses in New York, Chicago, Pittsburgh and Memphis.

COPPERWELD STEEL COMPANY WIRE AND CABLE DIVISION *Glassport, Pa.*

For Export: COPPERWELD STEEL INTERNATIONAL COMPANY, New York

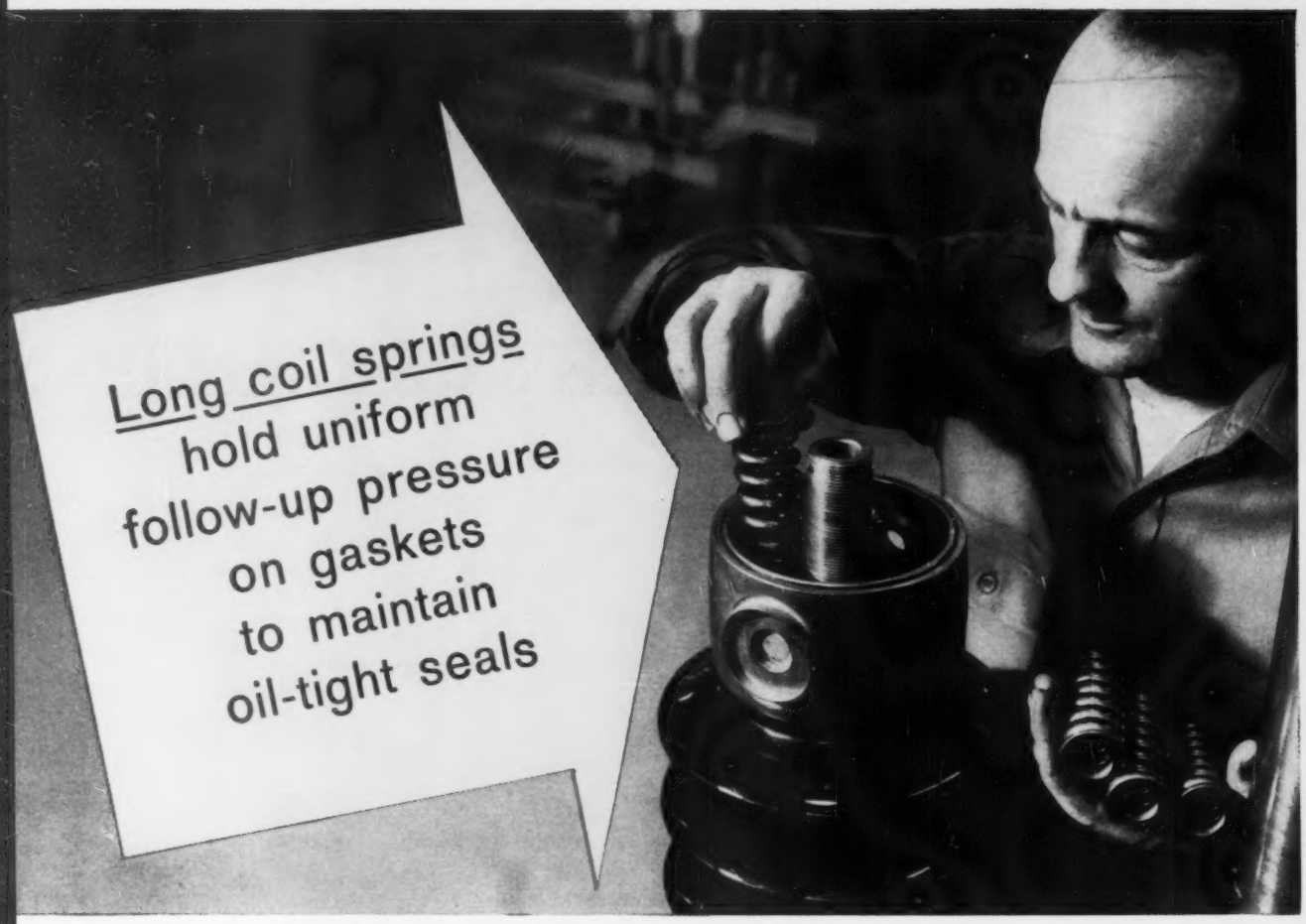
Canadian Distributor: NORTHERN ELECTRIC COMPANY LIMITED

LOADED with extra value

ALUMOWELD®

guy and messenger strand

He adds life to bushings



Who can predict how much rough treatment this bushing may receive during its life? Shock loads from circuit breaker operation, heavy cantilever loads, rough handling during shipment - - the bushing must be ready to take them all.

O-B puts long coil springs in the bushing assembly to make sure each joint remains oil-tight even under severe service conditions. Shock loads fall on a sealing system that is capable of complete recovery.

These springs, installed in the bushing reservoir, exert a uniform load on each gasketed joint between porcelain and metal parts. This spring pressure also compensates fully for the inevitable small loss of gasket volume under sustained compression and follows with uniform force the expansion and contraction caused by changes in equipment temperature.

O-B employs long coil spring assemblies in all voltage classes from 15-kv through 460-kv. To get the many advantages of these bushings, ask your apparatus builder to supply "O-B".

OHIO BRASS COMPANY, MANSFIELD, OHIO

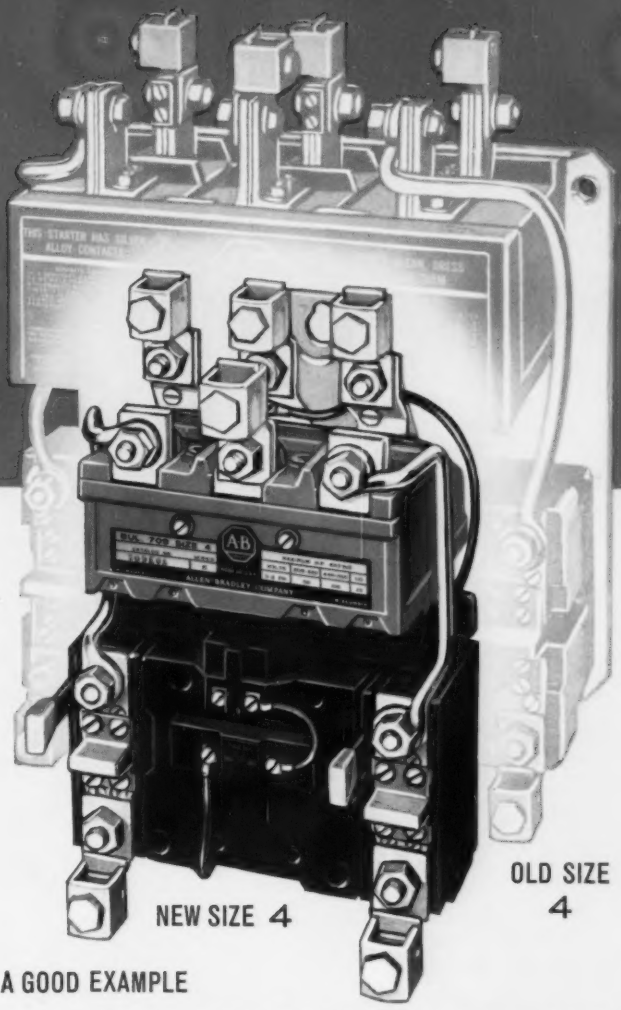
Ohio Brass HOLAN

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
BUSHINGS • HOLAN TRUCK MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

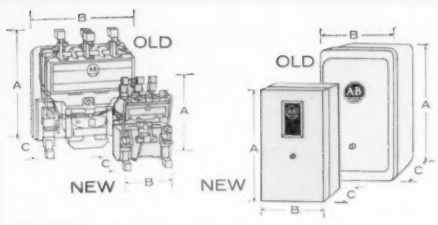
You get BIGGER PERFORMANCE

Plus SMALLER SIZE

with the new
Allen-Bradley
Bulletin 709 Starters



A GOOD EXAMPLE



The new revolutionary Bulletin 709 motor starters are surprisingly small in size—yet, they are good for many more millions of operations—without trouble or maintenance! Rating for rating, they have no equal. They are today's best starter value—and they cost no more!

The "Quality" you've come to expect in all Allen-Bradley control is represented in all details—especially in the "eye appealing" enclosures styled by the world famous industrial designer, Brooks Stevens. Write today for details of the new Bulletin 709 line—the greatest advance in motor control in 30 years: *Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin.*

14-61-RM

Check These New SPACE-SAVING Dimensions

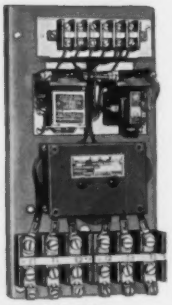
Starter Size	OPEN TYPE STARTERS						NEMA 1 ENCLOSURES					
	Height A		Width B		Depth C		Height A		Width B		Depth C	
	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD
00	4 1/8	—	3 7/8	—	3 1/16	—	7 1/16	—	4 7/8	—	4 1/2	—
0	5 7/8	5 5/8	4 1/8	4 3/4	3 1/16	3 1/4	9 3/16	7 7/8	6 5/16	5 5/8	4 5/8	4 1/4
1	6 5/8	5 7/8	4 5/8	5	3 1/16	3 1/4	10	8 1/16	6 1/16	6 3/8	4 5/8	4 1/4
2	7 5/8	10 1/16	4 5/8	5 3/4	3 1/16	4 7/32	12	14 1/2	7 5/8	9	4 5/8	5 7/16
3	10 1/4	12 5/8	6 1/4	7 1/4	5 7/32	5 7/16	16 5/8	19 1/2	10 3/8	11 3/8	7 1/4	6 1/16
4	11 5/8	16 1/4	7 3/8	12 3/4	6 7/8	6 15/16	22	26 9/16	11 5/8	14 3/16	8 1/4	7 1/16
5	15 3/8	20	9 1/2	16 1/8	8 5/8	8 3/4	32 7/8	41 1/2	17 3/16	19 9/16	10 1/8	13 9/16

ALLEN-BRADLEY

Member of NEMA

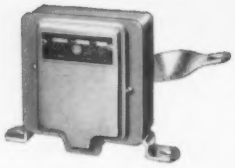
QUALITY MOTOR CONTROL

Your A-B Handy Catalog Lists These Control Devices Often Considered "Special"



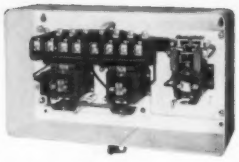
BULLETIN 812
Phase Failure—Phase Reversal Relays

Style F relay (above) protects against all open phase conditions on a branch motor circuit. Style R disconnects the motor upon a phase reversal. Style RF gives phase failure and phase reversal protection.



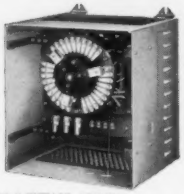
BULLETIN 840
Float Switches

These quality switches are available in a wide range of types for automatic control of motors operating tank or sump pumps. The snap-action switch mechanism assures positive operation, no matter how slowly the liquid level changes.



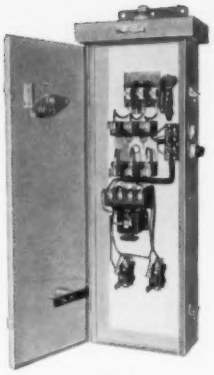
BULLETIN 1270
Automatic Transfer Switches

These switches are designed to transfer powerload to standby supply when normal power fails or drops too low. Automatically returns load to normal supply when power is resumed. Mechanically interlocked.



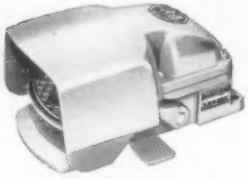
BULLETIN 555
Speed Regulators

Provide manual speed control of wound rotor motors for either fan or machine duty. When used with magnetic starter, the first step closes control circuit.



BULLETIN 1232
Pump Control Panels

Complete units for automatic operation of irrigation and oil well pumps. Employ standard A-B Bulletin 709 magnetic starter with manual disconnect switch or circuit breaker in weatherproof enclosure. Wide variety of optional features available.

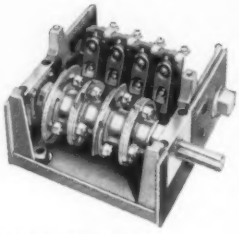


BULLETIN 805
Foot Switches

Ruggedly built to withstand the most severe industrial usage. Snap-action switch mechanism features maintenance free silver contacts. The foot switch shown above assures complete "safety" for the operator. Also made without top guard.

BULLETIN 836
Pressure Controls

For machine tool hydraulic systems operating at pressures up to 5000 psi. Oiltight enclosure. Operating pressure and differential are adjustable. A visible indicator shows trip point. Maintenance free silver contacts.



BULLETIN 803
Rotating Cam Limit Switches

Heavy-duty controls for use on automatic production machines. Made with up to 12 independent circuits which can be separately adjusted for operation at any point of rotation.

BULLETIN 365
Multi-Speed Drum Switches

Designed for manual starting, speed changing, and reversing of polyphase multi-speed motors. Made for up to four speeds either non-reversing or reversing.

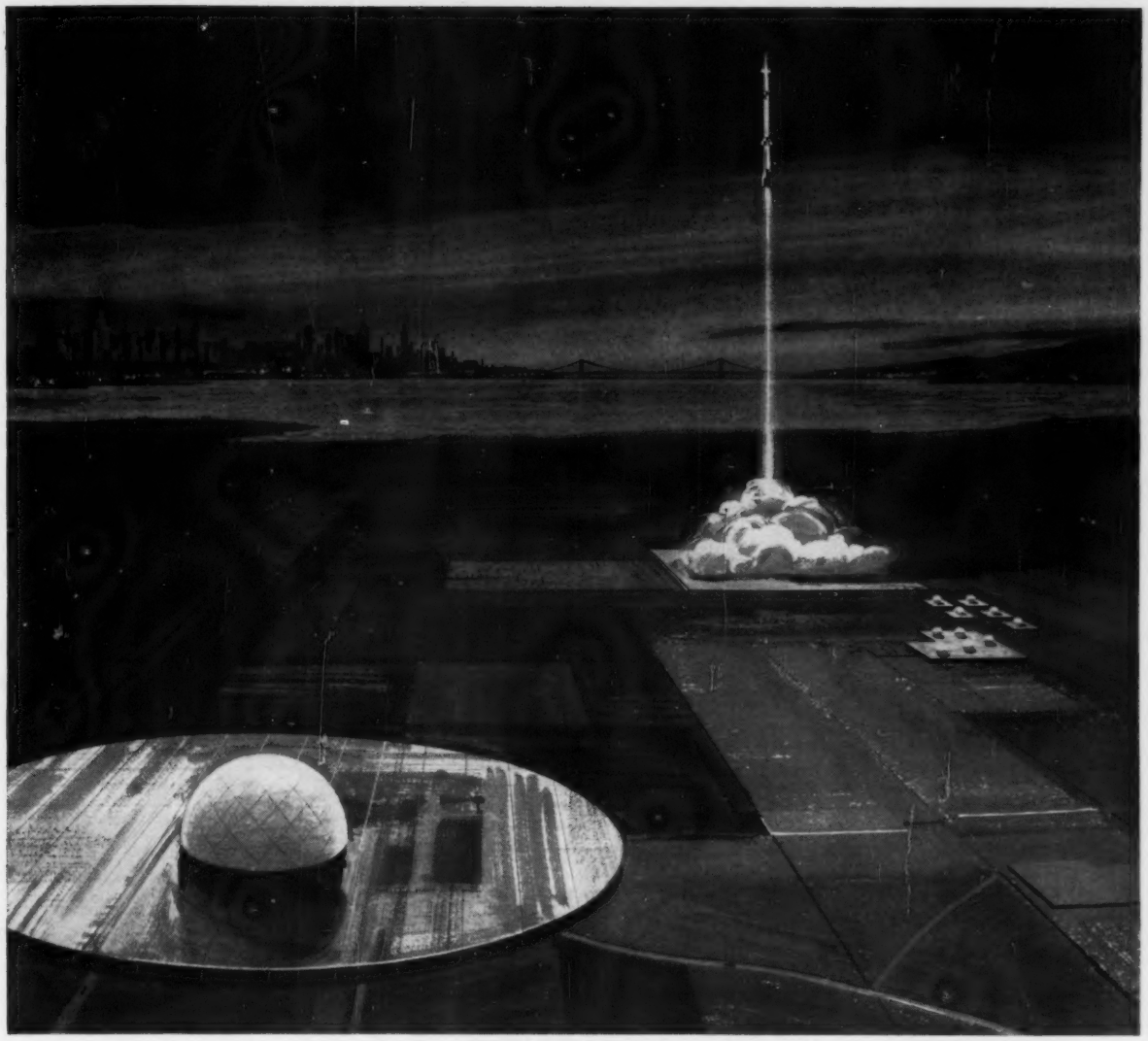
ALLEN-BRADLEY

Member of NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

QUALITY MOTOR CONTROL

14-61-RM



More than 450,000 pounds of thrust lifts the U. S. Army's Nike Zeus missile skyward in a cloud of vapor. The Nike Zeus missile being developed for the project by the Douglas Aircraft Company will be designed to intercept ballistic missiles traveling over 15,000 miles per hour, and destroy them at a safe distance from the defended area.

How do you stop an ICBM?

How do you detect, track, intercept—and destroy within minutes—an ICBM that is moving through outer space ten times faster than a bullet?

Bell Telephone Laboratories may have designed the answer: Nike Zeus, a fully automated system designed to intercept and destroy all types of ballistic missiles—not only ICBM's but also IRBM's launched from land, sea or air. The system is now under development for the Army Ordnance Missile Command.

Radically new radar techniques are being developed for Nike Zeus. There will be an acquisition radar designed to detect the invading missile at great distances. And a discrimination radar designed to distinguish actual warheads from harmless decoys that may be included to confuse our defenses.

The system tracks the ICBM or IRBM, then launches and tracks the Nike Zeus missile and automatically steers it all the way to intercept the target. The entire engagement, from detection to destruction, would take place within minutes and would span hundreds of miles.

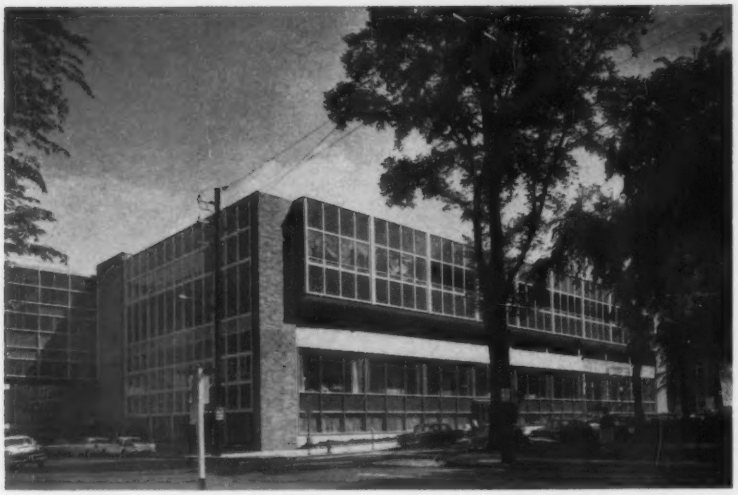
Under a prime Army Ordnance contract with the Western Electric Company, Bell Laboratories is charged with the development of the entire Nike Zeus system, with assistance from many subcontractors. It is another example of the cooperation between Bell Laboratories and Western Electric for the defense of America.

BELL TELEPHONE LABORATORIES

World center of communications research and development

MEARS low-voltage circuit breakers . . .

Designed for modern College Buildings



Portland State College's new 1½ million dollar "College Center" addition is completely up-to-date with a Mears 3000 A Fused Circuit Breaker. **Architect:** Lawrence, Tucker & Wallmann, Portland, Oregon. **Electrical Engineer:** Grant Kelley & Associates, Portland, Oregon. **Electrical Contractor:** Lord Electric Company, Inc., Portland, Oregon. **Mears Representative:** H. G. Lehl, Oswego, Oregon.

MEARS new 3000 ampere fused breaker selected for its ECONOMY and COMPACTNESS in the new Portland State "College Center."

Low cost and space-saving size were factors that resulted in choosing Mears for this modern student union center. Mears proven dependability with a high interrupting capacity guarantees smooth operation of the "Center's" bowling alley, barber shop, cafeteria, ballroom, etc. For today's modern college buildings —or any other type installations—Mears is the breaker to name.

MEARS-ENGINEERED breakers are offered in FIXED SWITCHBOARD, PLUG-IN and DRAWOUT mountings.

MEARS-ENGINEERED breakers are compact, economical and designed for reliability under the most severe operating conditions.

MEARS-ENGINEERED breakers are manually or electrically operated, in 600 through 4000 ampere frame sizes.

Call the **"MAN FROM MEARS"** in your area . . . or write to department EE-9 for your **Free Copy of the Mears Catalog** describing low voltage air and fused circuit breakers.

MEARS CONTROLS *Inc.*
13725 S. W. Millikan Way • Beaverton, Oregon

(Continued from page 8A)

Time Totalizer . . .

Small, inexpensive, and trouble-free, this device will be useful in preventive maintenance of defense electronic gear, machinery warranty, rental timing, life tests, and other intermittent timing applications. Functionally a mercury coulometer, it is operated by an integral electric network which compensates for temperature difference and voltage supply variations. Available in two basic models for a-c or d-c operations, both are designed for full-scale range of 1,000 hours. *American Machine & Foundry Co., AMF Building, 261 Madison Ave., New York 16, N. Y.*

500-Kva Substations . . .

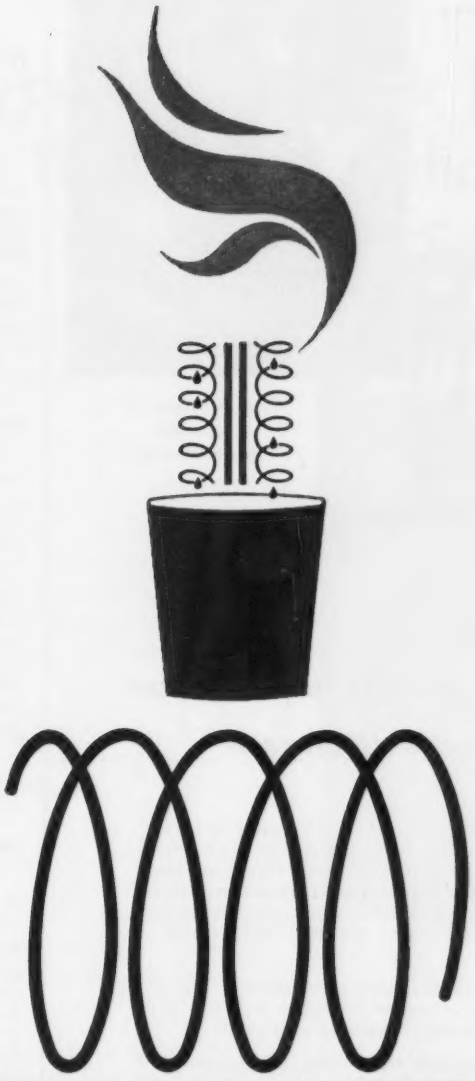
These new package unit substations combine compact size and easy handling with capacities from 75 to 500 kva, 3-phase, and primary voltages up to 4,800 volts, secondary to 600 volts.

A forced-air cooling system with high-temperature alarm can increase capacity by one third. Metering equipment, high-voltage air interrupter switches, *QMB* motor starters, main low-voltage power circuit breakers, molded case feeder breakers and *QMB* fusible feeder switches are also available. *Square D Co., Mercer Road, Lexington, Ky.*

Power Supply . . .

A new circuit concept used in this transistorized power supply provides precision regulation of ± (0.01% plus 1 millivolt) and reduced ripple of 0.5 millivolts rms. The *QCR 36-30* also features a continuously adjustable output from zero to 36 volts. Other features include remote control programming and a provision for constant-current operation. Load protection is provided by input-output fusing and an electronic circuit breaker with a trip point adjustable from the front panel. *Sorenson Products, Richards Ave., South Norwalk, Conn.*

(Continued on page 22A)



IN CLASS F POLYESTER MAGNET WIRE, SPECIFY ANATHERM-D FOR IMPROVED HEAT SHOCK RESISTANCE, VARNISHABILITY AND UNEXCELLED WINDABILITY

Anaconda has made important improvements in the heat shock resistance, windability, and solvent resistance of ordinary polyester magnet wire. The result is Anatherm-D, a Class F magnet wire with high thermal stability (155C) ■ High abrasion resistance ■ Excellent flexibility ■ High dielectric strength ■ Superior heat shock resistance ■ Unexcelled windability ■

IDEAL FOR ARMATURES AND FIELD WINDINGS. These improvements over standard polyester wires make Anatherm-D an outstanding choice for motor armatures and field windings, random- and precision-wound coils, specialty windings requiring high temperature resistance, and encapsulated coils.

2-FILM CONSTRUCTION MAKES THE DIFFERENCE. The improved performance of Anatherm-D results from its two-film construction: an overcoat of special terephthalate polyester applied over a base film of Anatherm (the industry's first Class F film-coated magnet wire). The outer film contributes outstanding windability and protection against heat shock and mechanical stress.

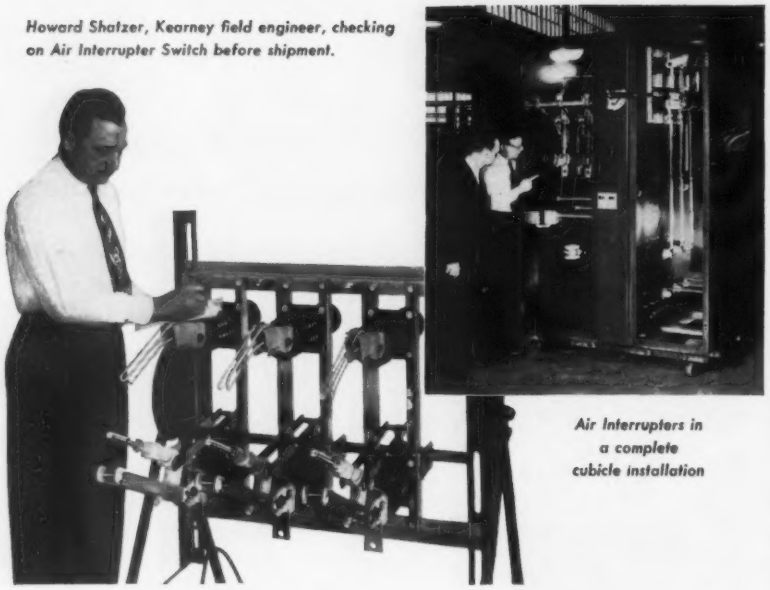
CONFORMS TO NEMA AND MIL SPECS. Anatherm-D magnet wire meets all requirements of Spec MIL-W-583B for Class 155 Types L, L2, L3, and L4. It's available in all sizes of round, square and rectangular, with single, heavy, triple and quadruple film additions, all conforming with NEMA specifications. Anatherm-D is available in all standard Anaconda packages: spools, pails, reels and drums. For prices, technical data and application information contact Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York, Department EFL-1-EE. 6137

ASK THE MAN FROM

ANACONDA®

FOR ANATHERM-D CLASS F POLYESTER MAGNET WIRE

Howard Shatzer, Kearney field engineer, checking on Air Interrupter Switch before shipment.



Air Interrupters in a complete cubicle installation

Specify KEARNEY...

for safe AUTO · SPEED interruption

in metal-enclosed switchgear

What is **Auto-speed interruption?** . . . An automatically produced interruption that always occurs at the same point in the switching operation, and always takes the same time (one-half cycle). Human error is eliminated from the switching action by a trigger spring mechanism which trips the switch at a pre-set point. Contacts are separated inside a dry type interrupter unit.

Specify safety for personnel and equipment. No exposed Arc. Kearney Air Interrupter Switches will not produce external arcing dangerous to men or equipment.

Specify economy. Costing less than circuit breakers and with interrupting capacity not found in air break disconnects, Kearney Air Interrupters are ideal for . . . interrupting magnetizing charging current of transformers . . . interrupting charging current of lines and busses . . . interrupting exciting current of feeder regulators . . . interrupting load currents to rated capacity . . . sectionalizing feeders and distribution circuits.

Specify Engineering Ability. Kearney's staff of engineers is experienced in adapting or combining equipment for complete switching centers or additions to existing units. Designing for unusual needs . . . corrosive or dusty atmospheres, unique space requirements, portable units, or carefully calculating tomorrow's expansion requirements . . . we are geared to handle the unusual.

Kearney Air Interrupter Switches are made in ratings up to 15 K.V.

3E's reliable Interrupter is now a Kearney product... unmatched for economy and safety

Write for Bulletin 152

KEARNEY

JAMES R. KEARNEY CORPORATION

MELROSE PARK DIVISION • 25TH & DIVISION STS., MELROSE PARK, ILL.

PLANTS IN ST. LOUIS • MELROSE PARK, ILL. • FAYETTEVILLE, ARK. • GUELPH, ONT., CANADA • ST. THERESE, QUEBEC, CANADA

(Continued from page 20A)

Glass Delay Lines . . .

Ultrasonic delays made of glass that serve as high-speed digital memories for computers and data-processing equipment are this company's latest development. Serial memories have been built that exhibit information rates of 3 to 20 megabits which are comparable to thin film, cyrogenic, and tunnel diode devices. Delay times as high as 150 microseconds have been achieved, and a 500-microsecond time is foreseeable. *Corning Glass Works, Corning, N. Y.*

New Galvanometer . . .

This modernized D'Arsonval galvanometer eliminates possible errors created by magnetic field variations or changing spring characteristics by comparing the signal fed into a servometer with the voltage obtained from a feedback potentiometer. Amplification of noncorresponding meter voltage to input voltage is achieved for large, erratic excursions by means of a self-contained transistorized amplifier. Maximum response is 50 milliseconds; power required for position indication is one watt. *Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y.*

Fast-Heating Cathode . . .

Capable of attaining full warm-up in 100 milliseconds, this new cathode will be used in future tubes for r-f power output stages in transistorized mobile and air-borne equipment. Because warm-up time from a cold start is almost instantaneous, full advantage of transistorized equipment can be achieved since stand-by current drain is eliminated. A rectangular frame along which many fine parallel wires are strung provides a very high surface-to-volume ratio, resulting in fast warm-up and thermal equilibrium. *Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.*

Cryogenic Sensors . . .

Two sensors, one for surface measurements and the other for internal probing, accurately measure temperatures between 4 and 40 degrees Kelvin (—269 to —233 C). Each one about the size of a 5-cent piece, the sensors are germanium semiconductors designed for test and operational phases of space vehicles using liquid helium and nitrogen. They can also be used in calibration and standards laboratories. *Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.*

(Continued on page 32A)

G&W Type N Network Switches Have That Extra Reliablility For A Demanding Service

TOP SERVICE is expected of a secondary network. Anything less than the best makes the headlines. But Top Service must be built into every single part of the system — including switches — if Top Network Reliability is to be realized.

G&W makes no network cables or transformers. But it does make network switches; we think the best in the business. Here are some of the reasons why.

G&W Standardized Type N Network Switches meet and exceed all EEI NEMA Standards:

1. Rated 15 kv, 95-kv Basic Impulse Level, 200-ampere continuous current carrying capacity, 5-second short-circuit rating of 15,000 amps in the grounded position.
2. Rated no voltage break or transformer exciting-current break, including appropriate electrical interlocking arrangement.

The Type N Network Switch incorporates components of proven reliability, demonstrated by years of field operation:

1. Patented rocker-arm switch construction, which includes Permali® stringer for holding the three-phase contacts (a specially designed laminate known for its excellent mechanical and electrical characteristics.)
2. "Z"-slot operating handle, which prevents overriding of the electrical interlocks by mechanically blocking direct operation from "off" to ground.
3. Encapsulated interlock coils, for use with either oil or askarel.
4. Magnetic oil-level indicator with retained gasket reduces the possibility of liquid leakage.

These are some of the significant reasons why any network-switch application is more reliable when G&W Type N Network Switches are specified as part of their construction. A complimentary copy of G&W Engineering data sheet No. 614.101 available upon request.

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superior quality standards — inspired specialized design

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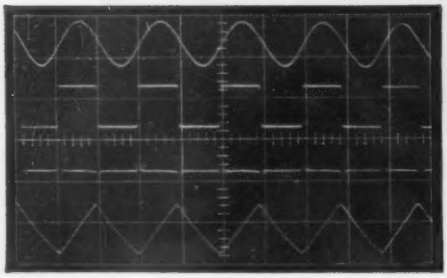
NEW

4-TRACE

PREAMPLIFIER

for Tektronix Oscilloscopes that accept letter-series plug-in units



TYPE M UNIT Seventeenth in the letter-series of plug-in units, the new Type M Unit adds multiple-trace displays to the wide range of applications possible with your Tektronix oscilloscope.

With a Type M Unit, you can observe up to four signals—either separately, or in any combination.

Independent controls for each amplifier channel permit you to position, attenuate, invert input signals as desired.

Other convenient preamplifier features—such as triggered or free-running electronic switching . . . ac-coupling or dc-coupling . . . and, after initial hookup, little or no cable switching—ideally suit the new Type M Unit for multiple-trace presentations in the laboratory or in the field.

For more information about this new 4-Trace Preamplifier, please call your Tektronix Field Engineer.

CHARACTERISTICS

Operating Modes—Any combination of one to four channels electronically switched—at the end of each sweep or at a free-running rate of about 1 mc (1 μsec width samples). Or each channel separately. *Channel Sensitivity*—20 mv/cm to 10 v/cm in 9 calibrated steps. Continuously variable uncalibrated between steps, and to 25 v/cm. *Channel A Signal*—available on front panel for optimum triggering in some applications. *Frequency Response and Risetime*—With Type 540-Series and Type 550-Series Oscilloscopes dc to 20 mc, 17 nsec. With Type 531A, 533A, 535A Oscilloscopes dc to 14 mc, 25 nsec. *Constant Input Impedance*—at all attenuator settings.

Type M Plug-in Unit $455.00
f.o.b. factory

Tektronix, Inc. *P. O. BOX 500 · BEAVERTON, OREGON / Mitchell 4-0161 · TWX—BEAV 311 · Cable: TEKTRONIX*

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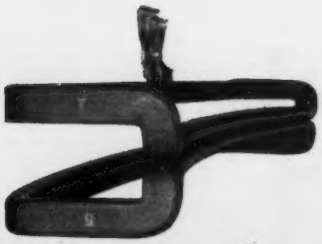
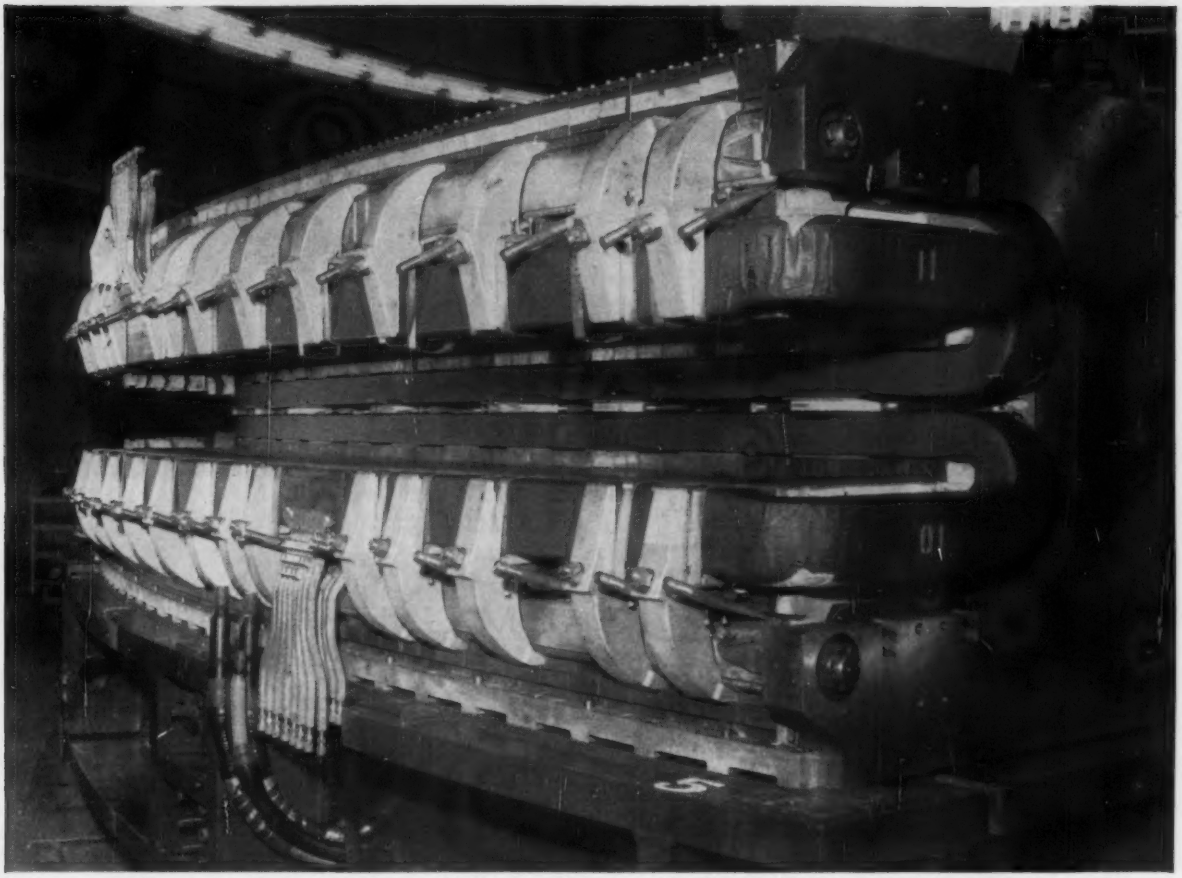


Upper and lower coils before installation.

National builds unique magnet coils for 3-billion electron volt accelerator



Coils assembled in magnet frame of accelerator. Note connections for cooling fluid which is circulated through hollow conductors.

For the new Princeton-Pennsylvania Accelerator, National manufactured, inspected, tested and delivered 40 finished magnet coils.

Some of the unique design features—which required special tooling and a new insulation system—were:

Extremely complicated coil configuration. Each coil was 12 ft. long, 2 ft. wide, and weighed 800 lb. Each coil was wound in eight individual layers, consisting of four turns of ½" square hollow copper conductor. No conductor splices were permitted internally in the coil. Each layer was wound with continuous conductor lengths of 92 ft. to 124 ft.

Rigid monolithic insulation system—required by the high pulse rate producing fatiguing mechanical forces. Turn-to-turn bonding strength is greater than 500 psi, and shear strength greater than 1000 psi.

Resistance to intense nuclear radiation—in the order of one million rads per hour.

National's experience in design and production of coils vacuum impregnated in Epoxy resins met the exacting requirements here, as on many other leading nuclear research apparatus projects. For help on your special coil requirements, call our Columbus plant... HUdson 8-1151 ... or the nearest National field engineer.

DIVISION OF McGRAW EDISON

National Electric Coil

COLUMBUS 16, OHIO • IN CANADA: ST. JOHNS, QUEBEC

When you need ***Switchgear*** *power...*

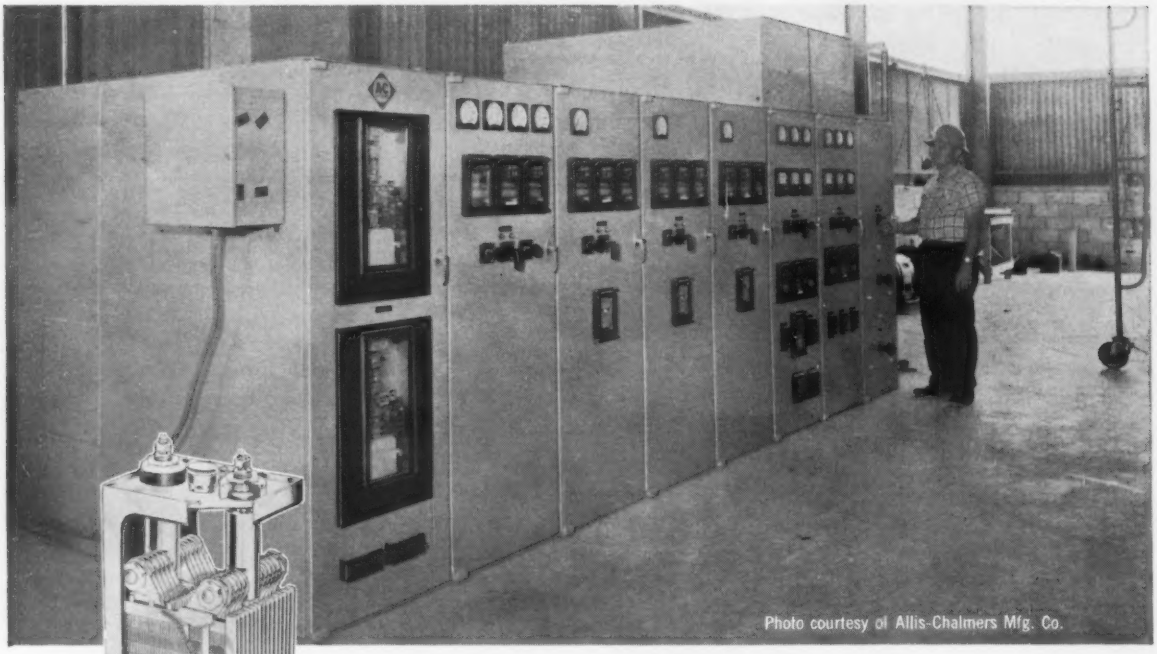


Photo courtesy of Allis-Chalmers Mfg. Co.

Depend on Reliable

NICAD NICKEL CADMIUM

Rechargeable Batteries

NICAD Nickel Cadmium Vented Cells were designed specifically for standby and control application. Extreme reliability, uninterrupted dependability at exceptionally low operating cost are features that have made NICAD the foremost nickel cadmium alkaline storage battery in service today.

Widely used by power plants, utilities, hospitals, airports and industry, NICAD batteries have provided maximum performance under extreme conditions, instantly and efficiently. The all-steel construction—virtually indestructible—and non-corrosive electrolyte gives NICAD batteries n greater life expectancy than that of any other type of battery.

All these features, coupled with unusually long shelf life when on open circuit stand result in an economical, dependable power source.

Here is round-the-clock readiness for the most critical application. Get the full POWER story from NICAD. Write . . .

FOR SWITCH TRIPPING								
CELL TYPE NO.	A. H. Capacity at 8 Hr. Rate To 1.14v Per Cell	DISCHARGE RATE IN AMPERES To 1.14 Volts Per Cell				To 0.98v Per Cell	CHARGE CURRENT Amps.	
		For 8 Hrs.	For 3 Hrs.	For 1 Hr.	For 1 Min.	For 1 Min.	7 Hr. Rate	14 Hr. Rate
JIX5	15	1.875	4.0	9	26	45	3	1.5
JIX7	20	2.500	5.4	12	35	60	4	2.0
JIX9	25	3.125	6.7	15	43	75	5	2.5
JIX11	30	3.750	8.1	18	52	90	6	3.0

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NICAD BATTERY DIVISION

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Business Trends...

FINANCING by the nation's privately owned public utilities increased by 77 per cent in the first 6 months of 1961, totaling $2.9 billion compared with $1.65 billion in the same period of 1960, according to Ebasco Services, Inc. Telephone utility financing amounted to $1.5 billion, a 333 per cent increase over 1960's first-half figure of $347 million.

• • •

PLANS for establishment of an electronic computer center in the Northstar business complex in downtown Minneapolis were announced by the Sessions Co., a management consulting firm. Contracts have been signed with General Electric for a new high-speed all-transistorized computer system.

• • •

THE U.S. Navy has awarded an $8 million contract to ITT Federal Laboratories for electronic air navigation equipment used in jet aircraft. These improved TACAN radio sets will provide aircraft with instantaneous, precise bearing and distance information.

• • •

SIXTEEN electronics companies were among the 190 United States and Puerto Rican firms who signed up for "Operation Bootstrap" factories in the Caribbean Commonwealth during fiscal 1960-61. It is reported that Puerto Rico's U.S.-affiliated electronics industry shipped a record $8.83 million worth of products to the mainland in 1960, an increase of 89 per cent over the previous year.

• • •

THE U.S. Atomic Energy Commission and Euratom have announced their signing of contracts with the Societa Elletronucleare Nazionale (SENN), an Italian utility, relating to the first project of the U.S.-European Atomic Energy Community joint power program. The General Electric Co., under a contract with SENN, is building a 150-mw electric boiling-water power reactor near the mouth of the Garigliano River in Italy.

• • •

A SMALL radar unit available for private airplanes and boats has been developed by Westinghouse. Its hand-held radar screen is like a telescope, with the essential part a high-resolution cathode-ray tube 7 inches long. The tube's screen is 0.60 inch in diameter and is magnified 10 times with an ordinary eyepiece. The pilot can keep the telescope-screen handy for checking and the rest of the transceiver can be remotely located for best weight distribution.

GENERAL Precision's Link Division received an order from Trans World Airlines for a Boeing 707 Jet Flight Simulator for about $1 million. Such a simulator enables 707 crews to conduct entire "flights" from one airport to another.

• • •

IT is predicted by the Electronic Industries Association that television set sales to the public in 1961 will exceed 6.2 million sets.

• • •

BECAUSE of Brazil's rapidly expanding industrial development, a 10-year program of at least 5 million kw of additional capacity covering the period 1955-1965 is now under way, thus raising that country's generating capability from about 3 million kw in 1955 to over 8 million kw in 1965.

• • •

THE Federal Communications Commission has amended its rules to provide fast removal from service electronic equipment which causes harmful interference to radio navigation and safety radio services. Of particular concern to the FCC is the so-called ISM equipment, used in the industrial, scientific, and medical fields.

• • •

ANNUAL sales of $50 million for electronic remote control supervisory systems are foreseen in the petroleum industry by 1965. These systems will be needed for pipelines, off-shore and leased wells, and refinery and process operations.

• • •

EMPLOYMENT in western electronic companies has reached 215,000, which is 24.6 per cent of the total U.S. electronic manufacturing employment, according to the Western Electronic Manufacturers Association. Also it was announced that sales in the western electronic field should climb to $2.8 billion—24.9 per cent of the national total.

• • •

AN automatic telecommunications system has been purchased by the Federal Aviation Agency for installation in the Anchorage, Alaska, area, from the North American Philips Co., New York. Reports from 65 FAA and other stations will be automatically switched to the proper receiving station in fractions of a second instead of by the present process of punched tape and manual placement in the proper circuit.

Power from Nuclear Reactions—Fission and Fusion

J. J. GREBE

A bold and imaginative approach to the use of nuclear energy—the wheel of space travel—is necessary if its potential is ever to be realized. If its true nature can be grasped, a vast realm of development will open for exploitation by many future generations of scientists and engineers.

THE PRESENT situation in the development of power from nuclear reactions is not very different from that of years ago when this writer gave a talk stressing the unique values and limitations of nuclear energy, plus the need for sound economics. Dr. Wigner and Admiral Rickover, 13 years ago, had outlined and directed the path to the production of safe and practical nuclear power for submarines at Oak Ridge, Tenn. More economical techniques for industrial power production were being sought even then. However, these techniques, in addition to being classified, were extremely complicated.[1] What has happened since is now history. Suffice it to say that we are still looking for an unsubsidized, sound approach to the industrial application of nuclear power. Its achievement is still projected 10 to 50 years into the future.

This does not imply a total lack of development in peaceful uses of atomic energy, such as isotope power for space, signal generators, medical application, and industrial control and analysis work. Each of these deserves more expenditure. Outer space exploration would be impossible without a source of concentrated lightweight nuclear energy. However, new industrial developments have continued to improve the efficiency and lower the cost of conventional power. Units have become bigger and more economical in first cost and operation, making nuclear energy harder to justify. The fuel cell promises to add another rung to the ladder. Such developments build up the efficiency, economy, and technology of our industry, and permit our American productivity to increase, and our industry to compete successfully with other nations whose labor rates are lower and whose skills and automation are rapidly advancing.[2] This is basic progress which I hope will never falter.

UNIQUE ADVANTAGES OF NUCLEAR ENERGY

BUT WHERE do we go from here in the field of nuclear energy? Let us look into the really prime advantages of nuclear fission energy.

J. J. Grebe is director of Nuclear and Basic Research, The Dow Chemical Company, Midland, Mich.

First, it is the cleanest and safest form of energy that man has yet learned to control. That statement may surprise many of you, as it would a vast majority of the public. To the layman, nuclear energy is a little known and mysterious power. Man has always feared that which is mysterious, and it may be indelibly associated in the public mind with weapons of mass destruction for many years to come.

Many are apprehensive about the slight increase in background radiation due to fallout and the like—but do they stop the production of carbon monoxide and oil smokes from their cars? People even take vacations in the mountains where cosmic rays are increased many times beyond the amount due to man's puny output through bombs and other nuclear conversion processes. But then, they are accustomed to enjoying mountains while the cosmic ray counters and the knowledge of increased radiation are new. I, too, justify being exposed to the great increase in cosmic radiation while flying high in a jet plane. I say, "It saves time." The time saved is so much more productive that I do not mind even knowing that it may shorten my life. We are all human with our fears, our rationalizations, our prejudices, and often irrational sense of values. Nuclear hazards are so easy to spot with modern equipment, and so easy to avoid compared to many other hazards to which man is exposed that one of our great challenges of the sixties may be to bring about a broader understanding of the safety and cleanliness of this form of energy.

The second great assets of nuclear energy are its great capability and small volume. In essence, the H-bomb converts a glass of water into the equivalent of trainloads of coal. This should make it possible for man to have the necessities of life in the form of food, clothing, shelter, transportation, and communication almost anywhere on earth—at a price. Perhaps before the decade is over this may apply anywhere in the solar system. The combined value of underground heat generation, and U^{233} and Pu^{239} breeding in H-bomb shots, using appropriate cavities produced in rock, may produce energy from D_2O, Th, and U^{238} at extra-low cost, even at remote locations.

The third and greatest advantage of all is that it is open to everyone. The very air we breathe, the water around us in such abundance, can and will supply this energy to everyone willing to tune in on it. But—and this is the real crux of our problem—by and large we have been unwilling to tune in on it. We have spent, overall, the enormous effort required for it, but have aimed too low. A new start is needed, and a disregard

of any process that does not honestly promise costs less than 0.5 cent per kilowatt-hour at the switchboard.

NUCLEAR ENERGY MISCAST IN TRADITIONAL MOLD

AGES OF HARSH EXPERIENCE were required to teach us to use gravity in the form of water power and winds. Then, in completely different ways we finally learned to use fire for steam power. So it should not be surprising that many engineers want to force nuclear energy to conform to practices developed for use with fire. We have tried to take the most precious new knowledge and squeeze it into the narrow mold of our past experience. We say, in effect, "We have the power and the resources to do it with the government behind us, so why not force things to work our way?" When will we learn that important new knowledge not only opens the door for additional new concepts but demands new concepts if we are to take full advantage of the knowledge we have gained? Let us keep the three great assets of nuclear energy in mind and try to orient our basic thinking in the direction that nature tells us is possible, rather than the direction we might like to decree for nature.

This challenge may be best appreciated if viewed in proper perspective. For a vantage point let us use the recent past. You remember the childish attempts to justify higher costs for nuclear energy which were rampant just 3 years ago. Some said: "What if the costs are high? The total cost of electric power is about 2% of our economy. To keep the remaining 98% electrified, we 'can' subsidize atomic power." The coal and oil fuel used amounts to about 1½ billion dollars now, or about ⅓% of a 500-billion-dollar economy. Others said: "Even 2% added cost can be carried by the economy." Now, there are many industries in which the management and the workmen would love the security of a 100% subsidy. Each would know how to use up all the surplus employable labor and engineering competence if we would only pervert fundamental economic law by man-made laws and rules and administrative decisions to provide such security.

But it is known from history that nature destroys artificial barriers which prevent each man's efforts from being as fruitful and as productive as possible. Nature does this either by competition within the family, the factory, the state, or the nation, or by going beyond and destroying the unhealthy mentality and the associated men and mechanical facilities in whole nations.

What does industry do about the situation of declining reserves of fuel easily mined and transported to the point of use? We are trying to figure out new ways to apply the magnetic bottle (magnetohydrodynamics) technology to use our fuels at temperatures rougly twice as high as those in modern furnaces. We are working to use the magnetic bottle not only to confine the high temperature and pressure products of combustion while it is ionized as a plasma, but also to serve as the turbine and dynamo for converting the heat energy of the expanding plasma into electric energy. We know only too well that this will not only require a higher quality fuel and higher energy air, but will actually force us into making clean coke and high-pressure oxygen, rather than permitting us to consume the lower grade reagents. There is no one more conscious than the writer of the need to do something about the recovery of sulfur and smoke-producing hydrocarbons which now smog the cities.

EXPLOITATION OF LOW-GRADE FUELS

IN THE NEXT 10 to 30 years we will solve the problem of using the lower grade fuels. There are nearly infinite amounts of these in deep, thin, high-sulfur, high-ash, or high-water forms, including lignite, tar sands, and pitch. A new process has been developed for using these lower grade fuels by one of our worthy competitors, F. J. Zimmerman, president of the Salvo Chemical Corporation, Rothschild, Wisc.

Let us take the particularly favorable case of a deep, wet deposit of nominally worthless coal. We drill a good-sized hole into the ground down to a mile or so. We produce a cavity by standard explosives, finally enlarging it into a "vapor-separating drum" by setting off a hydrogen bomb in it, at the bombing service price quoted by the AEC (Atomic Energy Commission) of a million dollars. We get fissures that intercommunicate between various coal seams and provide a cavity which can confine pressures of 2,000 psi under hydrostatic head of the overburden. This cavity is worth millions. The only leakage is into, rather than out of this pressure vessel. Starting with the heat of the bomb and later by the introduction of high-pressure air and water, steam is generated as long as there is anything combustible within reach.

It is astonishing what a few square miles of coal beds, just a dot on the surface of the earth, could do in providing power. In many parts of the world it could run the biggest power plants for 20 to 30 years. Even wet lignites can be "burned" in such cavities. We have experience on the by-product production of partially oxidized and other desirable organic by-products, particularly gaseous fuel. When the consumption of the fuel has provided a large cavity, bigger H-bombs can be fired below to generate heat for steam production.

A similar and related potential use for thermonuclear energy is in the area of chemical processing, that is, in the first stage processing of natural resources into basic chemical raw materials in natural or man-made underground cavities. This can be done with power as a coproduct. For example, a device detonated in a limestone formation would produce calcium oxide and carbon dioxide at a very low cost. The addition into these cavities of other basic raw materials, like coal, and further detonations, could yield new basic materials, such as calcium carbide for acetylene. In short, natural resources would be utilized, or first-stage processed in the place where nature deposited them. Mining, crushing, grinding, and heavy transportation would be eliminated or largely reduced.

In contrast to the approaches of independent indus-

tries, you may be shocked to know that present power reactor technology involves renting the fuel from the government at a very low rate. In addition, current technology for power reactors, even if as successful as hoped for, costs altogether too much in capital investment, similarly to costs of the Tennessee Valley Authority water power plants. Also, the fuel in reactors is leased only during the time it is working. A number of fuel loads must be provided so they can be cooled while the precious and potent fission products decay. Then, the largest percentage of the fuel may be reprocessed for reuse at a cost not yet brought down to practical levels.

There were those who did their best to help develop the technology for liquid metal self-regulating reactors to operate under vacuum rather than pressure, and that would be continually reprocessed by being milked of their valuable β and γ emitters. All the fuel would be working all the time. In fact, such reactors could be used to recover full values from spent submarine reactor fuel elements and to use up to the remaining fuel from any solid-fuel reactors as soon as it could be transported. Also, the plutonium-fueled fast breeder using liquid fuel and sodium alternately mixed and separated, would have had a very short fuel-doubling time. However, the most extensive effort to establish a liquid metal-fueled reactor was smothered to death by superconservative design, low temperatures, and low performance goals. When the political pressure to build reactors for prestige overruled the more realistic people, that goal was dropped. It is still hoped that these concepts will be understood before too long.

PERSPECTIVE VIEW OF NUCLEAR POWER

Currently, in spite of all the pessimism that is being expressed—in spite of the Russians publicly announcing de-emphasis of atomic power, just as they have de-emphasized flooding fertile valleys with high-cost hydropower dams; in spite of England, even with her long-range shortage of good coal, de-emphasizing and deferring her atomic goals—and with foreign emphasis on using low-grade fossil fuels by methods that are less clean and efficient than the Zimmerman process—there are still rather big objectives to be attained with nuclear power.

How then do we take advantage of the unique characteristics of nuclear energy? What would the system tailored to the characteristics of nuclear energy be like? We do not know how to express these points in any more terse and descriptive terms than were given in a paper the writer co-authored with A. W. Hanson, "Bigger Goals for Nuclear Energy."[3]

In essence, the story is as follows: In newly developed areas, even without highways, or where our present electric power distribution system is loaded to the gills, small automatic atomic power generating units will not only provide needed electric energy for the area, but also exhaust-heat for space heating and cooling cycles. We believe that liquid-metal fuel reactors will be used with helium-gas turbines. The liquid-metal fuel would be continually milked for the precious fresh fission by-products for industrial radiation, medical treatment, concentrated heat energy packages, and fission products batteries. City water will not be trusted, in time to come, unless sterilized with irradiation, locally. Such a substation will be considered the hospital, the warmth, the refuge, and safety shelter of the area. It will hug the airport instead of rivers or lakes.

The value of the decentralized fission energy will thus be multiplied by four, as compared to wasting the exhaust heat, and using β and γ radiation as mere Btu's in coal in a big central station. Reducing the dependence of the load area on the vulnerable and costly electrical distribution system alone multiplies the value of the local plants by two or more. These liquid-metal fueled nuclear stations will use all by-products, and operate automatically. In their best form, the automatic nuclear stations would be patterned after a subcritical neutron multiplier reactor by Lyle Borst. Only a hydroplant made to run only on overflow could be as bad as a nuclear reactor run at criticality. We have kept this dream alive by private research on materials of construction and liquid metal processing techniques for spent fuel elements, and the backing of Borst. Last year we received ⅓ million dollars from the AEC for carrying out more exact demonstrations of the feasibilities of our liquid-metal processing method.

What then about the broad picture? If we try to understand the nature of nuclear energy rather than trying to bend and twist it to old and conventional concepts, a vast and tremendously pregnant realm appears, to be explored by many generations of scientists to come. It seems certain to be the wheel of space travel.

THE ANNIHILATION REACTION

Let us go on a flight of fancy at 10 g acceleration to discuss very briefly the type of nuclear energy that will fill the sails of interplanetary ships—in space that will be charted to show the magnetic winds and cosmic ray currents. This energy is not radiation pressure, or thermionic emission, or even based on fission power generators for high-energy accelerators. Instead, it is what has been misnamed the "annihilation reaction," which occurs when an electron and a positron attract and fall into one another.

Good sound Maxwellian electrostatic and electromagnetic theory, proved by all of our electrical engineering technology, would call for a large amount of energy to be generated. The attractive force between a plus and a minus charge approaches infinity as the distance apart decreases to zero and, of course, a nearly infinite amount of force acting on even a short distance produces a lot of foot-pounds.

Three years ago, in trying to understand a plausible structure of the nucleus, I concluded that the currently accepted concepts of the annihilation reaction could not possibly be right, for they assume that all the energy is contained in the two or three γ rays emitted at each interaction. They add up to exactly the energy equal to the rest mass of the electron and the positron. But, what

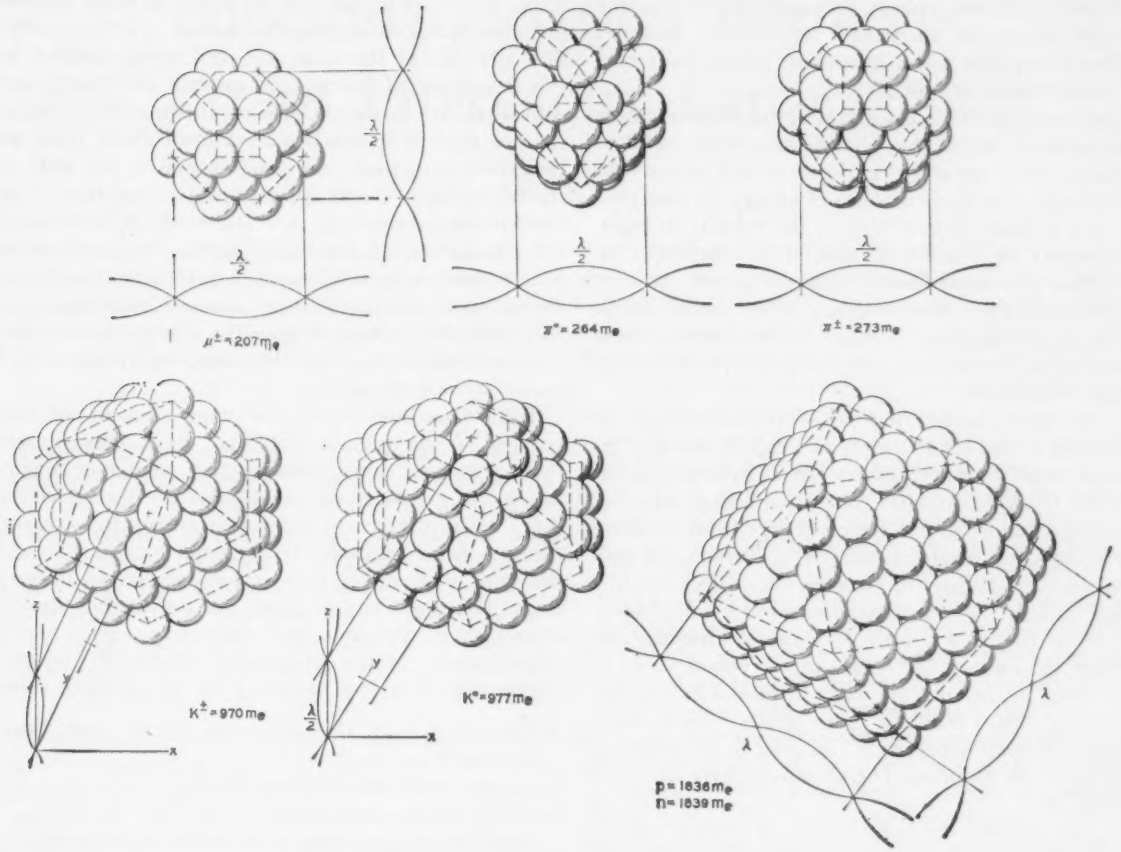

Fig. 1. Simple models of close-packed, cubic crystal structures bounded by squares, hexagons, triangles, etc., with equal sides

Table I. Major Steps in the Conversion and Organization of Energy

Entities Dealt With	Associated Phenomena	Causes, Methods, and Applications	Energy Changes
1. Proton—p^+, e^+, e^- accelerated by small cumulative field gradients	Relativistic mass gain with increased velocity. Ion streams in magnetic flux	Magnetic field energy increase within path of charge; electron gun welder	40,000
2. Coupling of e^+ and e^- to make $\beta\pm$ like ball lightning; now reproduced in laboratory	"Annihilation"; γ radiation	Space sail by magnetic lense for concentrating and deflecting e^+ and e^-, cosmic gas $-p$	10,000
3. Binding energy of:	Electromagnetic attraction	Magnetic field pulses	
a. $\beta\pm$ pairs to lepons	γ rays	Coupling energy	3,000
b. Couples to mesons, nucleons	Cosmic gas formation	Cosmic ray showers	1,000
c. Fusion, combining protons and neutrons to form higher isotopes, He, C, N, O	Sun's Δ source, bomb, underwater to fertilize oceans, underground for Δ and power	1. Mechanical work 2. Chemical work 3. Breeding nuclear fuel, Th $\rightarrow$ U^{233}	306
d. Fission—U or Pu + n $\rightarrow$ fips + Δ and radioactivity	Fission recoil Δ, plasma thermocouple	UF_6 in MHD plasma liquid fuel reactor	30
4. Radioactivity α, β, γ neutron emission. Natural and induced by bombardment	Geothermal heat from fission products and K^{40} decay. β^- ray battery	U to Pb, Th, to Bi thrust $-$kw and ion propulsion in space	3 to 1
5. Thermal radiation energy, ionization recombination	Sunlight, arc furnaces, evaporation, rain, fire, photosynthesis	Photocell, solar heat, battery, windmill, sails, water wheels	0.1
6. Molecular bond energies: freezing, thawing, boiling, condensing, combination, dissociation, polymerization	Chemical conversions, fire, electrolysis, steam power, full with fire	CO_2 in plasma flame, MHD—hot gas, chemicals, plastics, glass, and metals	0.01
Partial bond, surface tension	Fabrication	Food, clothing and shelter	0.001
7. Gravity, capillarity, waterfalls, tides, winds, waves, orbit of planets, comets, constellations	Water wheels, windmills, sails, drop hammers, construction and reconstruction	Electromagnetic attraction at 10^{23} cps, balloons, planes, porpoising, surges, physical work	0.0001
8. Living organisms	Vander Waal's forces, life cycles with recycle of portions not upgraded	Food collection for each higher stage of life. The drag, treadmill	?00001
9. Mind, instinct, habit, plus reasoning, invention	Experience, education, wisdom, learning mostly from mistakes of others	Communication, co-ordinated thought, arts, science, engineering	?000001
10. Spirit, temporal life and materialism sublimed to permanent values	The soil of GRIEF furnished by the unregenerate	Grows souls who LOVE the Creator and even all men	?0000001

happened to all the energy accumulated due to the attraction of one for the other? No one has answered this, but I can give you a hypothesis which leads to a very simple deductive analysis.

If you accept the classical radius of the electron which is the radius at which the electron mass m_e is equal to the charge, then the e^+ and e^- do meet long before they have gained a very large amount of energy. In fact, they meet at a velocity of $\pi/4^{1/4} \times c$, the velocity of light, which makes the relativistic mass after coupling 3 m_e each. They form what I found to be the largest common denominator in the mass spectrum of all matter, about 5.93 m_e as found in the proton.[4] It takes 309 of these $\beta^{\pm}$ couples to cluster four layers around the central $\beta^{\pm}$ to make a neutron.

H. H. Heighton has independently calculated the mass of the e^+ and the e^- couple to weigh a total of 6 m_e per unit. They couple to others just as hydrogen atoms form the H_2 molecule after converting energy equal to the mass of the e^+ and e^- into γ energy, thus emitting $25\% = 1/4$ their magnetic field (8 m_e) which was generated by their falling into one another. The coupling energy between two of these positronium units represents about 18%; 8.3% in the 38 units in μ mesons, and 2.5% for 165 units in the K mesons, decreasing down to about 1.0% by the time one has a cluster of exactly the four layers (308½ units) in p, the proton. Their diameter d is about the wavelength λ in space of the magnetic field within the $\beta^{\pm}$ units. The $\mu^{\pm}$ mesons have $d = \gamma/2$ (see Fig. 1).

All this explains the exact density of nuclear matter, the shortest wavelength that has been associated with nuclear forces, and also recent publications that allow for the possibility of positron and electron pairs having quantum levels that are higher in energy content than that of positronium.[5] It also meets the criteria set for explaining gravity and inertia.[6] In addition, the properties, such as nuclear magnetic moment, neutron cross sections, the stabilities and abundances, as well as physical properties of elemental particles and the elements, reflect the characteristics expected of roughly spherical assemblies of these close-packed cubic $\beta^{\pm}$ units in layers around a tetrahedral cluster of four central units or a single central one.[7] Positrons without partners within the nucleus can circulate on the periphery in fixed equatorial patterns by "cutting in" on the grand sashay of dozens of couples while flirting with the low-energy electrons in the outer orbits.

The slight differences in the binding energy as one goes up in the atomic mass to 29 layers amounts to 0.1% of the mass of uranium being liberated as energy when it breaks into fission products and radiated energy. This may seem small, but it is still very large, aggregating 200 million volts per U^{235} atom compared to the chemical energy of combustion, 3 volts, due to molecular bonding. It is also important to notice that annihilation γ energy is clean γ radiation of moderate intensity: 510,000 volts.

Thus we should harness the annihilation energy or, better, binding energy of e^+ and e^- and put it to work. This, I feel confident, will be done by large electromagnetic fields, increasing the chance of their interaction adjacent to the space vehicles, being shielded by this deflection, so that we can capture this energy and convert it into thrust. At present, this may seem fantastic, but there is so much more known about these interactions than there was about fission at the time of the beginning of the Manhattan project that there is no comparison between the two. Hundreds of accelerators are duplicating in laboratory bubble chambers what nature does in space. Magnetic field areas, enormous compared to laboratory targets, may achieve results that will astonish us. Depending on the relative velocity, the "furnace" would be about 100 times the diameter of a gas-air furnace on earth.

Table I outlines briefly the major steps in the conversion of the highest potential, most concentrated form of energy, into successive stages of higher organization and greater mass and dilution for the added energy. While the energy gain associated with each succeeding entity decreases, the degree of organization and the mass that moves with it becomes larger in each stage. The sensitivity to decay and destruction also increases about tenfold at each successive step of higher organization. Man's progressive efforts in tapping higher concentrations of energy for power sources are:

8. Life—the drag, the treadmill, (man- and beast-operated)
7. Gravity—sail, windmill, waterwheel
6. Fire—boiling, condensing
5. Sunshine—evaporation, solar boiler, solar battery
4. Radioactive decay—geothermal steam power plants, 6 ray battery
3. Fission–fusion—binding energy liberation, submarine power, fusion bomb
2. Coupling β^+ and β^- "annihilation" γ-ray-induced recoil and heat
1. Deceleration of charged particles—magnetic space sail (practiced in ray counters and electron gun welders)

Even the highest faculties of the human being draw directly and indirectly on energy in its most concentrated form, the electron—that 10^{-14}-cm-diameter magnetic bottle in the nucleus of the atom.

REFERENCES

1. Atomic Energy Applied, J. J. Grebe. *Chemical and Engineering News*, New York, N.Y., vol. 29, 1951, pp. 4151-57.
2. A Reappraisal of Nuclear Power and the Effect on our Fossil Fuel Resources and their Development, Philip Sporn. American Society of Mechanical Engineers, Annual Meeting of Fuels Division, New York, N.Y., 1958.
3. Bigger Goals for Nuclear Energy, J. J. Grebe, A. W. Hanson. American Institute of Chemical Engineers, New York, N. Y. (Nuclear Engineering Conference, Ann Arbor, Mich., 1954.)
4. A Periodic Table for Fundamental Particles, J. J. Grebe. *Annals of the New York Academy of Sciences*, New York, N. Y., vol. 76, Article 1, 1958, pp. 1-16.
5. Relativistic Electron-Pair Systems and the Structure of Neutral Mesons, E. J. Sternglass. *Physical Review*, New York, N. Y., vol. 123, no. 1, July 1961, pp. 391-398.
6. On the Possibility of Discovering Reflectors or Absorbers of Gravity and of Constructing Effective Sources of Gravitational Waves, F. J. Belinfante. *Essays on Gravity*, New Boston, New Hampshire, 1956, pp. 40-44.
7. Problems of Nuclear Structure, V. F. Weisskopf. *Physics Today*, New York, N. Y., vol. 14, no. 7, July 1961, pp. 18-27.

Educating Electrical Engineers for Professional Careers

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Since over 80% of our electrical engineering undergraduates intend to follow professional engineering careers, rather than careers in research and teaching, it is believed that a re-evaluation of the goals of electrical engineering education is required.

IN ANY current discussion of engineering education, and particularly electrical engineering education, it is inevitable that conflict will arise between those who wish to inject more science and mathematics into curricula and others who insist that engineering colleges should "train engineers—not scientists." Rather than support either side of this controversy I intend to discuss the subject of undergraduate education for professional engineers by presentation of the arguments for the following thesis:

The present emphasis on science and mathematics in electrical engineering curricula is creating a research-oriented type of undergraduate education that may lead to inadequate preparation for professional careers in engineering. Since 80% to 90% of our undergraduates intend to follow professional, rather than research or teaching careers, re-evaluation of the goals of electrical engineering undergraduate education is required.

ELEMENTS OF THE PROBLEM

THE CHARGE of inadequate education cannot be based upon the proliferation of science and mathematics in electrical engineering curricula. There can be no doubt about the necessity for increased emphasis upon these basic subjects in this age that is so often termed the "era of our rapidly expanding technology." It is equally important that college courses should concentrate on broad functions that are applicable to all branches of electrical engineering, with less attention given to specialized devices, design, shopwork, and so-called technical drudgery. As a result of this proper scientific attitude, engineering courses are unfortunately tending to stress mathematical analysis, based on idealized conditions and linearized parameters, with somewhat less emphasis upon the influence of physical limitations. Thus the student is placed in a never-never land where everything works exactly as the theory says it should. When these conditions are coupled with the philosophy prevailing in some quarters that an engineer is now only required to visualize and expound the problem and that the actual final solution is "trivial," it is possible for many nonresearch-minded graduates of our schools of electrical engineering to become mathematical robots, facile with differential equations but completely out of touch with the physical realities of engineering problems. Such men will be neither scientists nor engineers. They know that they are inherently without scientific creativity and their education has convinced them that engineering creativity is somehow beneath them.

The problem of the education of the professional engineer becomes even more complex when the characteristics of the present-day engineering student are considered. Many of these students are products of a progressive type of primary and secondary education that has heretofore failed to tax their mental capabilities. These young men have had their early education "spoon-fed." They have been allowed to pick and choose, to do only those things that they like to do, to avoid unpleasant, routine, and distasteful tasks. Many have decided to study engineering because of a natural aptitude for mathematics and physics. Others may have been influenced by the high salaries offered in newspaper advertisements to engineers. It is probable that these young men are not very different from their predecessors of a decade or two ago. It is only that their attitudes are different. They have learned to complain about being required to do unpleasant things. Courses in machine shop, surveying, drafting, fluid mechanics, and heat power seem like a waste of time, particularly since they may have heard that many members of the faculty agree with them. Unfortunately, this dislike of the mundane extends to such courses as elementary circuit theory, where it is often necessary to use numbers, push the slide rule, and obtain answers that must be interpreted with some engineering judgment. Enlightened present-day instructors, for the most part, have correctly abandoned the technique of the rote exercise and the dull repetition of routine problems. However, a certain amount of numerical work still remains in courses that retain their engineering flavor. One of my colleagues reports the amazement with which he was greeted when he required his computing classes to solve a reasonable circuit problem, involving complex algebra, down to the last detail. "Do you want us to work it *all* the way out?" he was asked. While the boys labored, my friend could hear them muttering to each other that "this dog work is for peasants."

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In an elementary machinery course two students incorrectly wired a d-c motor-starter set under the supervision of a novice instructor. When the resulting short circuit kept blowing the circuit breaker and the instructor could not immediately spot the trouble, the two "future engineers" left the laboratory in a huff, complaining that they were being required to waste their time on equipment that was "bad."

A senior-project student, working on a computing device, obtained a rather large and complex commercial electronic power supply that could be applied to his project with some modifications. Although complete wiring diagrams were available, the student insisted that he would require the services of a "technician" to trace the circuit and find out which relays were blocked. The student's computer circuitry was much more involved than that of the power supply and a few hours of effort would have removed all the difficulties. However, he strongly implied that he was above tearing into the unknown circuit and making it work.

These incidents are isolated examples, of course, but are indicative of the general attitude of today's engineering undergraduate. In many cases, this attitude is encouraged by the presence of young and sometimes brilliant faculty members who are themselves recent graduates and who have never engaged in engineering work. These young professors are often doing research work of their own, sometimes under generous government contracts, where factors of economy, reliability, and engineering judgment may be secondary. The areas of their efforts are most likely to be in fields where idealized and linearized parameters may be assumed with confidence. It is unlikely that they frequently encounter such troublesome materials as silicon steel in their research work. These men are engineering scientists for whom the differential equation and the digital and analog computers are invaluable tools. When they instruct undergraduates it is inevitable that their personal attitudes will be communicated to the students. Generally, only the upper 10% of each class can be expected to follow in their footsteps. The rest may be stimulated, but they necessarily obtain a distorted viewpoint of engineering work. It must appear to these remaining 90% that their chosen profession offers either a life of technical drudgery or a life of stimulating discovery. If they find that they will be unable to maintain the high standards required of research and graduate work, they fear that they may be condemned to the purgatory of ordinary engineering. Their lack of motivation for achieving technical excellence, engendered by early patterns of planned mediocrity and amplified by the frustrations of their engineering education, has led many of them to decide to become sales engineers, application engineers, engineering managers, engineering administrators—anything but professional engineers.

CRITERIA FOR ENGINEERING EDUCATION

EVERYONE agrees that the problems of evaluating engineering education are complex and difficult. The men who drafted the American Society for Engineering Education (ASEE) Grinter Report took 18 months to do the job. Every electrical engineering faculty in the country is endeavoring to find local answers to such problems as optimum number of semesters, ideal curriculum content, importance of the humanities, and related problems. It would be foolhardy, therefore, to suggest pat solutions to the multiple problems of inadequate undergraduate education. The problems vary with each institution and may be serious or negligible according to the temper of each faculty and student body. However, certain of the previously published commentaries on engineering education may be of use in providing guideposts for action.

In a recent editorial,[1] Dr. H. G. Booker, director of the School of Electrical Engineering at Cornell University, made the following two important statements concerning undergraduate education:

1. "The principal function of undergraduate education should be to develop the mind of a student by having him think through things that other people have frequently thought through before."

2. "There is nothing wrong, or even unduly specialized about engineering as a basis of education, undergraduate or graduate. Engineering provides a wealth of material for developing the minds of students on the basis of both well-known and novel ideas."

I shall call these statements the "Booker Criteria for Engineering Education." Although general in nature, they serve as appropriate yardsticks for the evaluation of any facet of the educational process.

Application of these criteria to the problems of educating electrical engineers for professional careers removes the confusion that has clouded certain issues. For example, there has been considerable agitation to banish the conventional machine laboratory, on the grounds that the devices are obsolete and that their development has reached a plateau. There can be no argument with such a proposal if machinery is still to be studied, as it has been for many years, by giving attention to a mass of winding detail, the study of specialized design techniques, and the grinding out of voluminous data for the purpose of drawing dozens of characteristic curves. Such practice violates criterion 1 in that the major portion of such detailed work does little to develop the student's mind and certainly is not conducive to making him think, except in a mechanical way. On the other hand, if the machine is studied as an actual physical device from the standpoint of the relative interaction of the various components and parameters; if the student is asked to "think through" the fundamentals of the device in much the same way as Faraday and Tesla and Lamme had to, then the study of the particular device is educational, by criterion 1. Criterion 2 is also satisfied through (1) the broadening influence of the study of the historical development of the machine and (2) the opportunity afforded the student to come into contact with the reality of an engineering device through observation of the manifestations due to nonlinearities and the interpretation of deviations from

theoretical predictions. If, in the process, he is disturbed by the inaccuracies of his measurement devices, intrigued by the difficulties of analysis of ferromagnetic circuits in motion, and appalled by his lack of knowledge of magnetic materials, he is receiving engineering education of the purest kind. The main point is that his mind is being sharpened on old ideas so that at some future time he can contribute new ideas of his own.

The process of idealizing and linearizing the machine so that it may be analyzed by abstract mathematics can be admitted as good educational practice only after the student is sufficiently sophisticated to comprehend the implications of his simplifying assumptions. To limit machine theory to the mathematical approach is poor educational practice by both criteria. Valuable thought processes are bypassed, an important bridge from past to present thought is never crossed, and perhaps worst of all, the student is left with unrealistic conceptions, often without a clear understanding of the limitations of his knowledge. The more discerning students exhibit a feeling of disappointment at this treatment. "I applied the equations of motion," said one graduate of this technique recently, "but I didn't learn much about machinery."

Granted that the object of electrical engineering education is not necessarily to learn about machinery, nevertheless an engineering teaching philosophy that fails to give the student a firm physical foundation upon which to build his mathematical concepts is comparable to a medical education which teaches the technique of surgery without first grounding the student in anatomy. Perhaps the would-be surgeon learns some anatomy by this process, but none of us would care to find ourselves on *his* operating table.

Needless to say, these comments apply not only to machinery but also to other areas of electrical engineering undergraduate education. For example, study of the characteristics of a vacuum-tube amplifier without an understanding of the fundamentals of physical electronics cannot be justified under either criterion. In short, engineering education based principally on mathematical analysis will not produce graduates who can apply their knowledge with judgment, or, as the Engineers' Council for Professional Development (ECPD) definition of engineering has it, "to develop ways to utilize, economically, the materials and forces of nature for the progressive well-being of mankind."

THE LABORATORY STEM

Present engineering education literature abounds with statements about the "core curriculum." In contrast, relatively little attention is given to the laboratory. Such mention as has been made would indicate that current trends are toward reduction in laboratory time, limited study of instrumentation, adoption of a policy of student laissez-faire in the choice of undergraduate laboratory projects, the already mentioned reduction of power machinery to bench-scale devices and a general attitude of "let 'em blow fuses," a concept of condoned laboratory carelessness based on the belief that the liberated, uninhibited student will learn more rapidly by making mistakes.

Perhaps these attitudes have been encouraged by the general agreement that "practical" or "specialized" training should be given to the graduate in the cadet programs of industry, so that only mathematics, physics, and engineering fundamentals need be taught in college. The fallacy in this argument is that industry does not care about developing the mind of the student. That job has presumably already been done by the school. Training in the specialty, not education of the individual, is what the cadet master has in mind. If the college has failed to instill the necessary engineering disciplines, standards of accuracy, comprehension of physical and material limitations, and desire for technical excellence in the student, it is too late. In isolated instances, an individual may possibly achieve these goals in industry. But how much broader is his education if he has been exposed to these concepts during the 4 or 5 years of a stimulating and critical academic atmosphere!

To provide adequate engineering education for all graduates in electrical engineering, every "core curriculum" should have grafted onto it a sturdy "laboratory stem." This program should parallel and complement the theoretical work throughout the required portion of the undergraduate program. Desirable features of such a program would be:

1. Avoidance of routine experiments, rote taking of data, repetitious computation, and standardized techniques.
2. Gradual development of the theory and application of electrical measurements as the student progresses.
3. Thorough understanding of the theory, behavior, and limitations of each instrument. There should be no "black boxes" in the laboratory.
4. Delayed introduction of sophisticated devices into measurement until such time as the student can fully comprehend them.
5. Inclusion of analysis and measurement of the characteristics of the various ferromagnetic materials and devices.
6. Thorough investigation of the electrical behavior of "real" devices, not idealized analogs.
7. Emphasis on the development of engineering creativity.
8. Provision for students to develop ideas with minimum assistance from instructors. However, free selection of topics for study should be avoided until the senior year.
9. Establishment of firm laboratory rules. Proper instrument care and personal safety should be stressed.
10. Encouragement of orderly, well-organized techniques. A blown fuse should be considered as the result of unwarranted carelessness until proved otherwise.

Throughout these laboratory sessions, the emphasis must be on complete comprehension of all aspects of each project. The experiments should be arranged with natural obstacles placed in the path of the students so that they will be required to exercise their growing

engineering judgment to overcome them. There should be ample opportunity for the observation of phenomena that deviate from the predictions of theory. Mathematical analysis should be encouraged whenever possible. Where mathematics cannot be used, physical analysis should be employed.

Examinations on laboratory work should be creative. Problems that depend on mathematical derivations should not be used. The problems should be engineering problems that require thought, analysis, understanding of concepts, and good judgment. Problems that require the mere parroting of material absorbed in class should be avoided.

It is unlikely that the students will react favorably to such a program at first. Their present backgrounds and mental attitudes will probably cause them to be unreceptive to such tough treatment. If the parallel theoretical program is equally challenging, there will be a number of important benefits; incompetent students and would-be "managers" and "salesmen" will be eliminated early. The serious ones who remain will have ample opportunity to decide whether they wish to follow research or technical careers. By proper choice of electives, the students in each group will be able to prepare themselves for the careers of their choice. In either case, their undergraduate education will have been thorough and will have given them adequate preparation for the future.

REFERENCE

1. What is Wrong with Engineering Education, H. G. Booker. *Proceedings*, Institute of Radio Engineers, New York, N. Y., vol. 42, no. 3, Mar. 1954.

Receivers for the National Emergency Alarm Repeater System

F. H. INDERWIESEN

The NEAR system, a recently developed means for rapidly alerting the population in case of emergency, operates by an alarm signal transmitted through the power lines. Operational requirements of the system and technical features of the receiver are discussed.

THE PROBLEM of civil defense, in an age of possible nuclear warfare and intercontinental missiles, affects the entire population. Direct enemy action or fallout against any community can multiply casualties indefinitely unless the public is warned and knows the steps it must take to survive.

The superiority of electric power lines to any other means of warning the population is clear: 96% of the population of the whole country is serviced by electric power, as compared to 73% having telephones. Although 94% of the people have radios, only 8% of these radios are turned on at any one time.

The NEAR (National Emergency Alarm Repeater) system, developed by the Midwest Research Institute, transforms part of the 60-cps power into a 240-cps signal. The alarm signal can be transmitted through the power lines to a special receiver, which is plugged into any power receptacle. Upon receiving a signal, the receiver will alert all people within audible or visual range.

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OPERATIONAL REQUIREMENTS

THERE IS a broad range of operating conditions to be met in the homes of the United States. These conditions introduce many problems and limitations on the design of the NEAR receivers. The factors pertinent to the engineering problems are as follows:

Signal Level. The NEAR receiver must detect a 1-volt 240-cps signal sustained for 3 minutes, on a 115-volt 60-cps power line. Strong signals of 4 to 6 volts should not result in deterioration in the operation of the receiver. The receiver not only must sense a frequency of 240 cps, but also must have the means to determine which signal, among all the coded signals and power-network transients with 240-cps components, is the one intended for home warning.

Ambient Noise Level. The 115-volt 60-cps voltage must, in this instance, be considered as "noise." Harmonic voltages, usually odd multiples of 60 cps, exist on the a-c power line and persist for extended periods of time. The results of measuring the ambient power-line spectrum between 40 and 1,200 cps, over a period of 3 years in the States of Kansas, Missouri, Ohio, and Michigan are contained in Table I. The amplitudes

are maximum rms values and were sustained longer than 1 minute.

Table I. Power Network Ambient Spectrum Analysis

Even Harmonics		Odd Harmonics	
Frequency, cps	Amplitude, volts rms	Frequency, cps	Amplitude, volts rms
60	132	180	5.0
120	0.5	300	5.5
240 (signal) (channel)	0.2	420	2.2
360	0.1	540	0.25
480	0.1		

Interharmonic noise is of a transient nature and usually lasts less than a second. Natural noise, such as that caused by direct lightning strokes, contains a 240-cps component, which usually decays within a second. Man-made sources of 240 cps are caused by large rectifiers supplying direct current for electroplating, or by electric arc furnaces. These sources of interference are of a localized nature and may be treated individually, if necessary. Asymmetric inrush in transformer switching can cause up to 3 seconds of 240-cps noise.

Environmental Conditions. The factors of temperature, corrosion, aging, shock, vibration, humidity, and safety must be considered in designing the receiver for reliability and long life.

The receiver may encounter a temperature of 32 F in an unheated Alaskan home or 120 F in an unventilated Arizona home, and it must function reliably in either place. Components and packaging must be selected carefully to prevent the corrosion and aging which could make the receiver unreliable. Many kitchens occasionally produce gases that tarnish silverware and play havoc with electrical contacts. Shock and vibration, although not severe in the home, may be quite severe during the process of transportation to the point of distribution, handling and unpacking, etc.

Alarm Requirements. The prime objective of the NEAR system is to reach people at home, any time, and to alert them to the threat of possible disaster. In most cases, a distinct audible alarm is satisfactory for most of the population.

A study of the factors that influence the audible alerting of people in their homes has been made.[1] A visible or tactile alarm is required for the deaf.

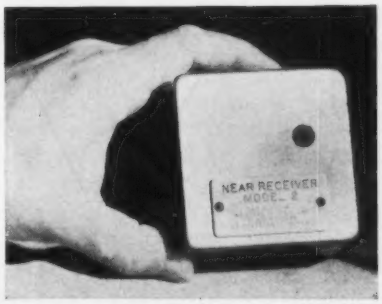

Fig. 1. Prototype of the NEAR receiver with sync motor time delay

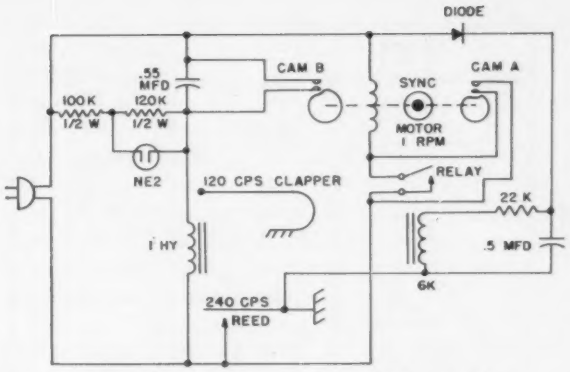

Fig. 2. NEAR receiver circuit with modified time delay

The influence of the following factors were evaluated to provide the basis for the design of the receiver alarm:

1. Size of the average American home
2. Acoustical effect of architectural features in the home
3. Audio acuity of the average listener
4. Ambient noise level and frequency distribution within the average home
5. Location of the listener with respect to the alarm device
6. Effective loudness and effective "annoyance" value of the alarm

Of the factors listed, only the sixth is under the direct control of the alarm designer. An alarm, in order to alert, must be annoying. Annoyance value increases with increased pitch, use of multiple frequencies, and introduction of silent periods between sounds. The sound should be distinctive so as not to be confused with home doorbells, telephones, or buzzers. The louder the sound, the better is its ability to attract attention.

TECHNICAL FEATURES OF THE ELECTROMECHANICAL RECEIVER

Description of the Cycle of Operation. The receiver (Fig. 1) is energized by plugging into a power receptacle in the home. An orange glow from the plastic jewel on the top of the case indicates that the receiver is energized and that the a-c line voltage is not below normal. The receiver circuit (Fig. 2) provides an insight into the several modes of the operation cycle.

Detection of the NEAR signal is partially accomplished by the *L-C* series-resonant circuit connected across the a-c line all of the time. The 240-cps mechanically resonant reed is caused to vibrate in the air gap of the inductor *L* by the magnetic flux resulting from the signal current.

Actuation of the time delay, the synchronous motor, and the alarm is caused by the reed intermittently closing a contact. Power is taken from the 60-cps line through the reed contact, is rectified by a diode, and causes a sensitive d-c relay to close after the first few

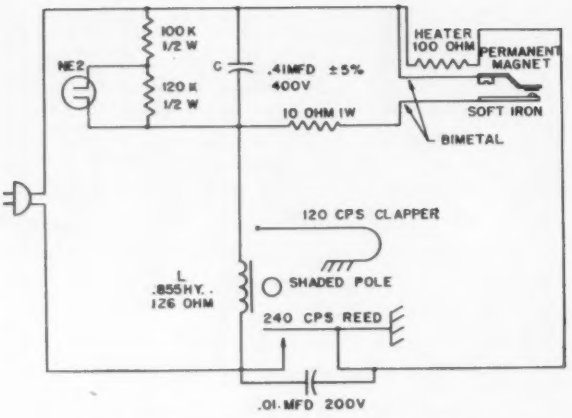

Fig. 3. Circuit of NEAR electromechanical receiver

cycles of the reed's motion. The contacts of the relay apply power from the 60-cps line to start the timing motor. If the signal stops within the first 10 seconds, the relay contacts open and the timing motor is reset to the starting point by means of a return spring. After 10 seconds, cam *A* on the motor closes contacts which override the relay and permit the motor to control the alarm cycle.

The alarm is actuated by the movement of cam *B*, which causes the tuning capacitor *C* to be periodically short-circuited. When the capacitor is short-circuited, the full 115-volt 60-cps line current is applied to the inductor *L*, causing the 120-cps clapper to be driven to sound the alarm. The total alarm period is 50 seconds, after which cam *A* opens, returning the receiver to stand-by operation. A magnetic latch locks the reed during the alarm period, preventing further operation of the relay.

The circuit of an earlier version of the NEAR receiver, which was also tested, is shown in Fig. 3. Its primary difference from the Fig. 2 circuit is in the method of obtaining the 10-second time delay. The external appearance of this receiver may be seen in Fig. 4. The cycle of operation is similar to that already discussed.

Selectivity. The ideal filter, to provide a margin of reliability, would require a *Q* of 80 to 100. Cost considerations prohibited the use of filter networks made up of toroids and capacitors. Electromechanical filters, such as resonant reeds, torsion resonators, and tuning forks, have *Q* values of 100 or greater at 240 cps. These devices are ideally suited to this application because of low cost, rugged construction, and reliability. If the *Q* is limited to approximately 100, the need for close-tolerance components and temperature compensation is avoided. Furthermore, the reed filter also serves as a mechanical amplifier by the addition of an electric contact to it, to control considerable power and so avoid the use of electron tubes or transistors.

The selectivity curve or frequency response of the mechanical filtering system is shown in Fig. 5. The rejection of 60-cps currents is obtained by electrical tuning in combination with the mechanical resonant system. By comparing Fig. 6 with Fig. 5, the improvement in selectivity may be noted. The instrumentation used for making measurements on the receivers is shown in Fig. 7. A discussion of the selectivity requirements and the electromechanical impedance of the receiver is contained in the appendix.

Sensitivity. The receiver was designed to operate reliably with a threshold signal of 1 volt at 240 cps. However, the receiver needs to function at 0.6 to 0.8 volt, in order to allow for some loss of sensitivity with aging, and to avoid the polarity effect. (The polarity effect is a difference in sensitivity displayed by the receiver when plugged into the receptacle one way, then reversed; it results from the asymmetrical waveform produced by 60-cps and 240-cps currents combined.) The 1-volt threshold signal represents a signal-to-ambient noise ratio of about 5 to 1, which gives the receiver an acceptable safety factor and aids in the prevention of false alarms.

The NEAR signal causes a small, magnetically polarized reed to vibrate at its natural frequency when the reed is positioned between the poles of an electromagnet. The force tending to attract the reed in the air gap is a function of the magnetic flux density and the cross-sectional area of the gap:[2]

$$F = 0.0139\,\beta_a A_a$$

where

Fig. 4 (left). Prototype of NEAR home warning receiver with thermal time delay

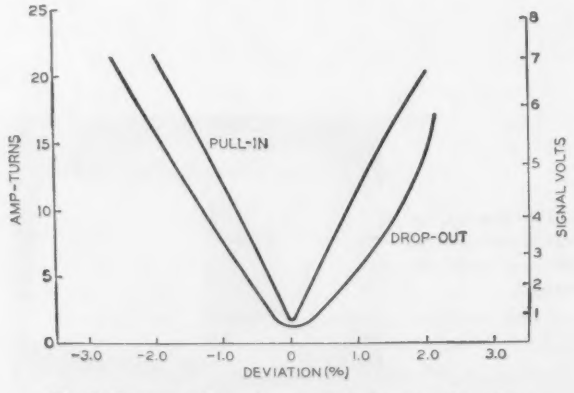

Fig. 5. Response of tuned mechanical elements of receiver

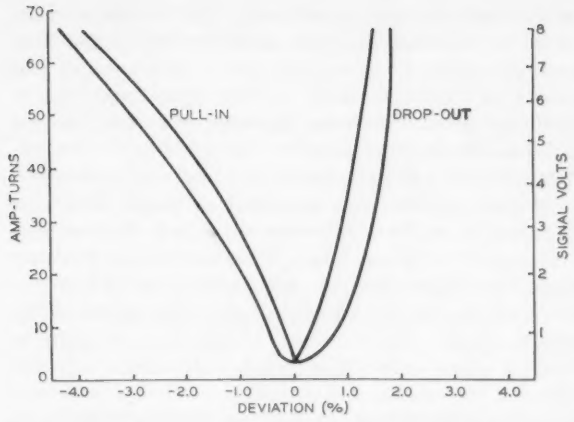

Fig. 6. Combined response of tuned electrical and mechanical elements of receiver

F = force acting on the reed
β_a = flux density in the air gap
A_a = cross-sectional area of the core faces

The sensitivity and the amplitude of vibration of the reed for a given force is governed by Young's modulus, density, and permeability of the reed material, and the length of the reed from the clamped end to the point of contact.

If the driving inductor is placed directly across the a-c power line, the reed would be forcibly driven by the large 60-cps current. Several advantages are gained by series tuning the inductor to resonate at 240 cps. First, the impedance of the circuit to 60-cps current is raised, and the noise current reduced. Secondly, the 240-cps impedance is minimized, affording the best impedance match to the power line. The sensitivity is improved, because the greatest amount of signal current is extracted from the power network. An iron core is required by the inductor to increase the inductance value. A low-value capacitor may be used for resonance. The core also carries increased flux during the alarm cycle of operation when the clapper is driven.

Transient and False Alarm Protection. False alarms must be kept to an absolute minimum to insure continued acceptance of any warning system by the public. False alarms could conceivably be caused by unintentional or accidental signaling, coded signals, network transients, or failure of components within the receiver. The receiver cannot prevent false alarms caused by unintentional or accidental signaling. The proper choice of components and ratings will help to insure long life and a minimum of false alarms resulting from receiver failure.

Network transients of a natural or man-made origin cannot be avoided. However, these transients have a common characteristic also shared by the coded signals: they persist for a short duration, usually less than a second. For example, a lightning discharge near a power network is a source of a 240-cps transient.

Tests in the field of receivers not having transient protection showed that too many false alarms occurred. The best of several methods for the prevention of false alarms was a short time delay of about 10 seconds between the start of the signal and the alarm actuation. The time delay causes transients and code pulses to be rejected.

An earlier model of the receiver, shown in Fig. 8, had a bimetal type of time delay actuated by 60-cps power metered through the reed contacts. This method was tried first because of its simplicity and low cost. An undesirable feature of the bimetal time delay is its energy-storage characteristic. The thermal build-up follows an exponential curve analogous to the voltage rise across a capacitor when the capacitor is charged from a battery through a resistance. This means that repeated transients or coded pulses could eventually cause the receiver to sound an alarm.

Field tests of receivers having the bimetal time delay indicated that the delay was a function of the signal level, a-c line voltage, and temperature. The thermal relay was quite sensitive to vibration from the alarm and had to be shock-mounted. The reed contacts had to carry considerable current to power the thermal relay and, as a result, the life of the contacts was shortened. Although no false alarm due to transient signals was ever recorded during field tests of this type of receiver, coded signals would cause tripping. Therefore, the decision was made to use a synchronous-motor type of delay, although the cost was greater. The motor delay was found to have these advantages:

1. Time delay was independent of signal voltage level.
2. Time delay was independent of a-c line voltage.
3. Code pulses would not accumulate to trip the receiver, because the gear-train mechanism could be returned by spring action about four times faster than the normal forward driven rate.
4. A cam switch avoided production adjustment of the time delay period.
5. Motor and mechanism were virtually vibration-proof.
6. Reed contacts now operated under "dry circuit" conditions, prolonging life and increasing reliability.
7. Alarm time could be lengthened and accurately

Fig. 7. Instrumentation used in measuring the electrical impedance of receivers

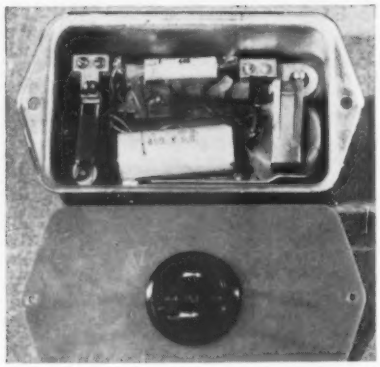

Fig. 8. RBM Company receiver with base removed

controlled, even to providing on and off action, thus making the alarm more distinctive.

RECEIVER OPERATION UNDER SIMULATED HOME CONDITIONS

ALL NEAR RECEIVERS were evaluated in two steps. First, the receiver was laboratory tested under many conditions related to its performance, in order to establish a confidence or reliability figure. Then the receiver was field-tested in Battle Creek, Mich., on all major circuits and in surrounding locations having adequate signal strength. For these tests the RBM Company, a division of the Essex Wire Corporation, Logansport, Ind., manufactured to specification 100 receivers having a thermal time delay.

Operational tests were run at ambient temperature, 32 F, and 125 F. The signal voltage was varied from 1 to 3 volts, and the 60-cps line voltage was varied from 90 to 130 volts. The delay time and the alarm time of the receiver were recorded at each operation. Ten-volt signals of 180 and 300 cps were applied individually and in combination to determine the immunity of the receiver to false operation.

These data were then analyzed statistically. Occasionally, a receiver was selected at random to be given a life test. The test consisted of cycling the operation of the receiver as rapidly as possible, with a counter or recorder attached to indicate the number of operations accumulated until some component failed. Daily sensitivity and selectivity tests were run on the receiver in order to determine the degree of deterioration. Each receiver had to meet the minimum requirements successfully before it was sent to Battle Creek for field test. Valuable information on quality control was obtained from the environmental tests. Receivers having the thermal time delay have exceeded 5,000 operations. Receivers similar to those having the timing motor delay have easily operated 100,000 times with no loss of sensitivity or other apparent deterioration. This is equivalent to almost 14 years of twice-a-day operation.

RECEIVER OPERATION DURING FIELD TESTS

EACH RECEIVER was then field tested on all major circuits in Battle Creek and surrounding locations having a 1-volt or greater signal. Automatic recorders were selected to limit the number of persons necessary to conduct tests and to eliminate the human element as far as possible. The operations recorder functioned unattended for 24 hours or longer. Correlation of this record on a real-time basis with the programmed signal from the generation gave the true operations, misses, and false alarms.

Special field test carts were designed and assembled, each housing 20 receivers within a sound-deadening chamber. Carts were mounted on wheels for mobility and ease of handling. Fig. 9 shows one of the field test carts; the 20-pen recorder, one channel for each receiver, is shown on the extreme right. The left-hand recorder charts the a-c line voltage between signals; when a signal occurs, the recorder switches automatically and records the 240-cps signal level. The receivers are on shelves behind the door on the side of the cart. The doors are locked to prevent tampering. All charts have a velocity of 12 inches per hour, permitting resolution of operations only 5 minutes apart, if needed. Normally, the home warning signal was programmed on the hour and coded signals sent on the half-hour.

One location in each power substation circuit was sampled in Battle Creek. In addition, an area within a radius of 40 miles of Battle Creek was spot checked. Except for the behavior of the signal with the network load condition, no situation that had not been simulated during the laboratory tests was encountered.

The field data were analyzed statistically to determine the reliability of the receiver under actual operating conditions. When it became apparent that the thermal time delay was incompatible with receiver operation on the code pulses, a number of these receivers were modified.

Standard 1-rpm synchronous timing motors furnished by the Lake City Company, a subsidiary of Controls Company of America, Schiller Park, Ill., were substituted for the thermal relays. The motors were controlled by sensitive relays made by the RBM Company. Both of these components, which are being mass-produced, give long service. A spring return and cam switch were the only additions to the motor. The RBM signal-sensing unit was used without modification except for the change in the time-delay method.

The few false alarms that were recorded were traced to a defect in individual receivers. The test cart containing 20 receivers also simulated apartment house conditions, where interaction between receivers might be expected, but such was not the case. Actually, no

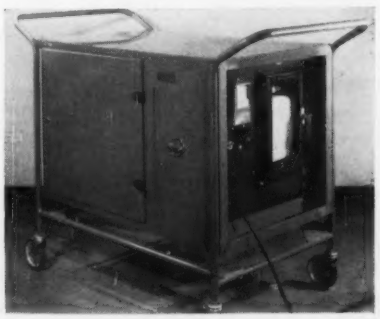

Fig. 9. Test cart for monitoring receiver operations in the field

false alarms due to network conditions were recorded, proving the effectiveness of the time-delay principle.

CONCLUSIONS

THE PRESENT PROTOTYPE receiver can be expected to operate reliably with normal home conditions. Improved techniques and quality control are expected to boost reliability of production models. Present receiver reliability is above 99%, based on the ratio of operations to signals.

If a threat should arise, the NEAR system receiver could be put into production in quantity at once.

Appendix

Selectivity Requirements. The minimum tolerable selectivity or figure of merit Q was derived from the noise and signal information presented in Table I. If

Z = series circuit impedance
R = circuit resistance independent of frequency
F_0 = 240-cps resonant frequency
Q_0 = minimum tolerable circuit Q at resonance

then the assumption is made that $Z/R=10$, ± 60 cps removed from the signal frequency, F_0. Since $Z/R=1$ at resonance, then 10 volts of either the third or fifth harmonic would be equivalent to 1 volt of the 240-cps signal. Then, from reference 3,

$$Z/R = 1 + jQ_0 \frac{(\gamma^2 - 1)}{\gamma}$$

where

$$\gamma = \frac{F_2, \text{ actual frequency}}{F_0, \text{ resonant frequency}} = \frac{300}{240} = 1.25$$

solving for Q_0,

$$Q_0 = \frac{(Z/R) - 1}{\frac{j(\gamma^2 - 1)}{\gamma}}$$

Substituting values, $Q_0=20$ at the resonant frequency of 240 cps. Thus, 20 is the minimum tolerable value, with no allowance made for noise or a safety factor. A more acceptable value would be between 80 and 100.

Electrical Impedance of an Electromechanical Filter. The motion of the mechanical system has the effect of modifying the electrical impedance of an electromechanical filter, especially near resonance. The total driving-point impedance is

$$Z_{ee} = Z_e + Z_m \quad \text{(vector sum)}$$

where

Z_{ee}= total driving-point impedance
Z_e = blocked or electrical impedance
Z_m= free reed or motional impedance

The electrical impedance Z_e consists of the series combination of resistance and capacitive and inductive reactances. The electrical vector impedance is easily measured if the movable mechanical elements are firmly blocked in the neutral position. The plot of this impedance versus frequency is a straight line, parallel to the reactance co-ordinate. If the admittance of this circuit is plotted versus frequency, the result is a circle. The plot of the motional impedance versus the frequency in the vicinity of resonance is also a circle, since the electrical impedance is proportional to the mechanical admittance of the reed.[4] The performance of the receiver in terms of resonant frequency, bandwidth, sensitivity, selectivity, and stability can be predicted from the analysis of the circle diagram.

The total driving-point impedance Z_{ee} can be measured electrically from the a-c plug on the receiver, if the movable mechanical elements are free. The impedance plotted versus frequency in the vicinity of mechanical resonance results in a circle. An instrument both useful and time-saving for taking these measurements is the vector impedance bridge (model *VB-1*, Harris Transducer Corporation, Woodbury, Conn.), shown in Fig. 7, together with the audio-signal generator and cycle counter for frequency measurement.

The motional impedance, Z_m, circle can be easily determined in graphic terms after the electrical Z_e and driving-point impedances Z_{ee} have been plotted. Much information can be obtained from the motional impedance circle. For example, the diameter, drawn from the origin, intersects the circle at the frequency of mechanical resonance. The bandwidth can be determined from the half-power frequencies located at the intersection of the circle by a second diameter perpendicular to the first. Since these frequencies and the resonant frequency are known, the Q of the mechanical system can be found from

$$Q = \frac{F_0}{F_2 - F_1}$$

where

F_0 = resonant frequency
F_1 and F_2 = frequencies at the 3-db (bandwidth) points

Loading the mechanical system by a fixed contact against the vibrating reed has the effect of increasing the bandwidth and reducing the Q. The greater the ratio of the unloaded Q to the loaded Q, the greater the efficiency of the system.

Distortion in the circle represents other losses associated with the mechanical system, and should be avoided. Flexibility in the reed mount or the core assembly can easily be detected.

REFERENCES

1. Alarm Requirements for the NEAR System Receivers, F. H. Inderwiesen, *Contract no. CD-SR-58-24*, Midwest Research Institute, Kansas City, Mo., Sept. 1958.

2. Magnetic Circuits and Transformers (book), Electrical Engineering Staff, Massachusetts Institute of Technology, John Wiley & Sons, Inc., New York, N. Y., 1943, p. 120.

3. Radio Engineers Handbook, F. E. Terman, McGraw-Hill Book Company, Inc., New York, first edition, 1943, p. 141.

4. Electroacoustics (book), F. V. Hunt, Harvard University Press, Cambridge, Mass., 1954, p. 97.

650-Kv Substations for Project EHV

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THE General Electric Extra-High-Voltage Project (called "Project EHV" for short) comprises a complete prototype transmission system which operates at 500 kv, and will operate later at 700 kv (750 kv maximum). It was announced[1] in 1958, but technical work and acquirement of the right of way had been proceeding since early 1957. The cost of the entire project is estimated at $7,500,000 and is being contributed by 11 co-operating manufacturers and one utility. Construction work on the site was started in May 1959 and energization at 500 kv of the North Substation and adjacent section of the line took place in December 1960. In 1962 the voltage will be raised to 700 kv. Plans call for testing until the summer of 1963.

In the past, ehv research installations[2] have been designed as open-ended test lines with limited and nonrepresentative terminal equipment. Usually, no effort was made to design the system for a given voltage. Instead, a broad range of voltages and system parameters was investigated. The design philosophy of Project EHV is more advanced, similar to that used by utilities in establishing a new system. On the basis of forecasts of development of ehv transmission in the United States and Canada,[2] it was decided to design all Project EHV line configurations specifically for 460 and 650 kv, and both substations for 650 kv. A voltage of this magnitude appears to be adequate for fulfilling transmission requirements in North America for the next 20 years.

Project EHV includes prototypes of apparatus to be used on future ehv systems, from 460 to 750 kv. For instance, the capacity of the two 650-kv autotransformers was set at 40,000 kva, because calculations showed that this was the smallest size of a forced-oil-cooled unit, which would have basically the same construction and geometry of larger units of the same basic impulse insulation level (BIL). Actual service experience will be obtained for several years under normal weather and operating conditions.

As mentioned, the Project EHV line was designed for two rated voltages, 460 and 650 kv. Conductors, hardware, and line insulation will be changed when the operating voltage is raised. The two terminal substations, however, are designed only for the 650-kv level, with the exception of the lightning arresters, which will be rated 360 kv during operation of the system at the 460-kv level. It appears that the same design principles and structures will be used for apparatus and substations in the 460- to 750-kv range. Consequently, operation at the highest voltage is sufficient to demonstrate the correctness of the design and its economics and reliability. Furthermore, two 460-kv substations have been built by the Pennsylvania Electric Company for their Claysax Project, and operating experience will be available from these installations.

The following design criteria for the two Project EHV 650-kv substations are fundamentally the same as would be used by a utility, but are modified in certain aspects by the special instrumentation requirements:

1. The apparatus and structures are representative of future designs for 460 kv and higher voltages. At present, both rigid and strain busses are being used for 345-kv substations, and it appears that both may be used at higher voltages. Consequently, rigid aluminum bus has been used for the North Substation, and strain bus, consisting of bundled ACSR conductors, for the South Substation.

2. Radio interference from the stations is negligible compared to that generated by the line itself. This requirement is definitely more stringent than that which would be used by a utility. Conductor-generated corona and radio noise are at present important factors affecting the design of ehv lines, and therefore they will be measured by means of 23 radio-noise meters and a special device which will separate the corona pulses, according to their magnitude, and count them. For theoretical and practical reasons, it is desired that most of these pulses originate on the line and not in the station. Television interference from the station is negligible, since this usually results from hardware in poor condition or from slack insulator strings.

3. Station insulation requirements are established by lighting and switching surges, rather than by 60-cycle voltages or overvoltages, because there are no insulator pollution problems in the Berkshires. However greater distances had to be used at times between phases than would be necessitated by insulation requirements, because special instrumentation for corona loss measurements needed to be accommodated.

4. Mechanical design criteria require that the structures withstand the severe weather conditions of the area, but that they be easy to erect, despite their large dimensions. Maintenance should also be kept to a minimum.

Digest of paper 61-155, recommended by the AIEE Substations Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 29-Feb. 3, 1961. Published in AIEE *Power Apparatus and Systems*, Aug. 1961.

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REFERENCES

1. Project EHV, P. A. Abetti. *Electrical Engineering*, vol. 78, Aug. 1958, pp. 669-74.

2. Progress in Extra-High-Voltage Power Transmission, P. A. Abetti, S. B. Crary. AIEE *Transactions*, pt. III, (*Power Apparatus and Systems*), vol. 78, June 1959, pp. 357-71.

OERSTED

and the Discovery of Electromagnetism

Part IV

BERN DIBNER

FELLOW AIEE

This is the fourth and concluding article of the series on the discoverer of electromagnetism and his epoch.

THE next important step in the evolution of electromagnetic theory and apparatus was that made by William Sturgeon (1783-1850) of England who, in 1825, wound an electric wire in 16 turns around a soft iron core and so produced an electromagnet. He found soft iron to be better than steel because it was capable of stronger temporary magnetism than steel. This was true only while the current was flowing, soft iron lacking the retentivity of steel. Sturgeon bent the iron core into a horseshoe shape thereby bringing the poles into the same plane and further intensifying the magnetism, as well as making its influence upon an iron object more convenient. The conductor that he used was bare wire wound around the soft iron core which had been heavily varnished so as to insulate the successive turns of the bare conducting wire. This electromagnet had distinct advantages over a lodestone: strong lifting power, instantaneous magnetization, immediate ending of the magnetic field when the circuit was opened, and the ease with which the electromagnet could be positioned anywhere.

HENRY'S CONTRIBUTIONS

To Joseph Henry, teacher and experimenter at Albany, N. Y., goes the credit for masterful work in exploiting these properties. Instead of varnishing the iron core, he concentrated on providing an insulating cover upon the conductor itself. He used a silk winding about the copper wire and thus could closely pack many turns upon the iron core. This he demonstrated at the Albany Institute in June 1828. To one small magnet he applied 35 feet of wire in 400 turns and showed the improved properties of such a magnet in the following year. As a next step he wound two layers of turns about a core, connecting the coil ends at each pole end together, thus joining the coils in parallel. The resulting pull was nearly doubled. This opened the general field of inquiry to Henry, a mathematics teacher, as to which variables—number of turns, size of wire, kind of battery, number and method of connection of coils—were those from which the optimum condition of magnetic strength was to be determined. He found that with the current from a single pair of zinc and copper plates only 1 inch square, he could construct a magnet to sustain 85 pounds of iron. With a single cell of less than half a square foot of surface, 650 pounds could be sustained. In 1831 he built a magnet having an iron core weighing less than 60 pounds, yet it was capable of holding up more than a ton. Another magnet which Henry made held up 3,600 pounds. Thus, in about a decade after the announcement of the principle of electromagnetism, an electric battery, no larger than the one that first showed Oersted its magnetic property, was used to sustain a weight of a ton.

ELECTROMAGNETIC INDUCTION

THREE events provided the stable base of modern electrical science: the discovery of a constant-current source of electricity by Volta, the magnetic influence of an electric current by Oersted and, finally, the generation of an electric current from magnetism by Faraday.

Ever since Oersted's announcement that magnetism could be generated by electricity, the hunt for the reciprocal condition, the generation of electricity from a magnetic source, became the goal of experimenters. Michael Faraday (1791-1867), of most humble beginnings, was assistant to Sir Humphry Davy at the Royal Institution and, because of his brilliance as an experimenter, become one of the immortals of science. For 10 years he had worked on the problem of conversion of a magnetic force into electricity, but without success. However, on August 29, 1831, he observed that when two coils were wound around a common core and one was connected to an electric battery, the making and breaking of the electric current in the first coil created a kindred pulse of electricity in the second coil in the circuit of which a galvanometer had been inserted. Thus, electromagnetic induction was discovered.

As a further step in following this discovery, Faraday, on October 28, 1831, mounted a copper disc so that it could be made to revolve between the pole ends of a powerful magnet. Galvanometer leads were then con-

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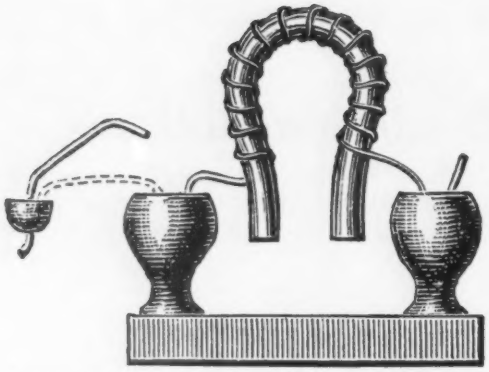
This is part IV in a serialization, in four parts, of the book of the same name published by the Burndy Library, Norwalk, Conn.

Bern Dibner is chairman of the board, Burndy Corporation, Norwalk, Conn.



Sturgeon, in 1825, wound 16 turns of bare copper on a varnished soft iron core. When current was switched through, it lifted 9 pounds, or 20 times its weight, a prodigious accomplishment for the first electromagnet

nected, one to the axle of the revolving disc and the second to the disc's edge. When the disc was turned by a crank, the galvanometer needle deflected, clearly showing that electric currents had been induced in the disc. The first dynamoelectric machine had been born and from it rose the electrical age. In 10 days of intensive experimentation, Faraday had grasped and formulated the basic laws of magnetoelectric generation. These results were presented in the first of a long series of papers before the Royal Society of Sciences on November 24, 1831. To the chemical source of electric generation of Volta there was added the magnetoelectric form of generation by Faraday. Mechanical energy was now convertible into electric energy. By adding the concept of the magnetic field with its lines of force (as dramatically demonstrable with iron filings) Faraday physically linked the elements that engaged in magnetoelectric generation.

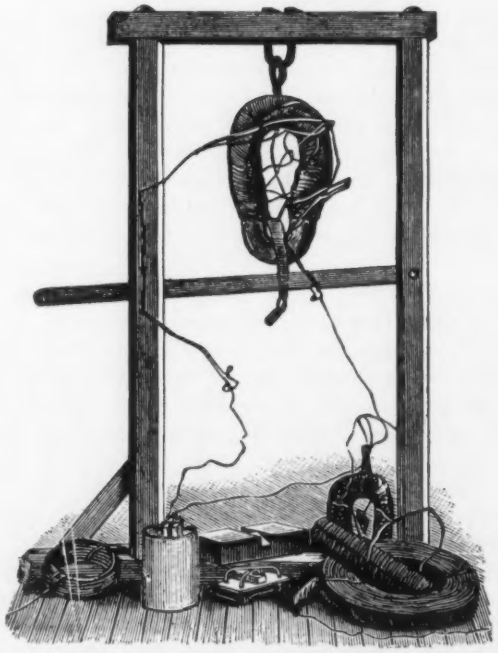
The principle of self-induction was first observed by Prof. Joseph Henry in 1832, with the apparatus shown on the accompanying illustration. With this apparatus he obtained a brilliant spark when he opened a circuit connecting an electric battery to a coil of copper wire. This occurred when he quickly broke the circuit by using a copper jumper joining two cups of mercury in the circuit. From his experiments he concluded that in order to obtain this spark it was necessary for the length of wire to exceed 12 or 14 yards. An even better effect resulted when the wire was coiled into a helix.

THE ELECTROMAGNETIC TELEGRAPH

Building with the elements created by Oersted's announcement of the discovery of electromagnetism, Ampère was probably the first to suggest this new force as the means of transmitting signals over an electric wire, a suggestion that led to our modern telegraphic system. If a needle, argued Ampère, could be deflected by an electric current, then this motion could be converted by code into an alphabetic system. Because the number of wires required proved too unwieldy, the practical application of this arrangement failed, as had earlier electrochemical proposals. However, Sturgeon's electromagnet gave new impetus to the inventors in telegraphy. Various needle telegraphs were invented, promoted, and shelved. In 1834, Gauss and Weber drew a telegraph line between the laboratory and observatory over the rooftops of Göttingen that was a mile and a quarter long. Double wires connected magnetic indicating needles, and the line continued in use for 4 years until it was struck by lightning. It was improved by Steinheil who substituted a single wire and ground return. The English experimenters William F. Cooke and Charles Wheatstone expanded Schweigger's idea into an operating telegraph.

The telegraphic art received its final impetus by S. F. B. Morse, who combined the primary elements of Sturgeon and Henry into a practical telegraph system, and then promoted its construction and use until it became, in its day, the universal means of long-range communication. In March 1843, with support from Congress, a telegraph line between Washington and Baltimore was constructed by Morse, and it proved feasible.

Oersted and Faraday first met in London during the former's visit to England in 1823. They remained in correspondence for nearly 30 years and met again during Oersted's later visits to London. On Oersted's second visit to Faraday's laboratory in 1846 he expressed very great interest in the large horseshoe electromagnet that Faraday had constructed and with which he had conducted experiments in diamagnetism. When Oersted



Joseph Henry insulated the wire of his electromagnets with silk, compacted them with many turns, and connected the coils in parallel and in series, increasing the suspended weights to over a ton. With this apparatus he discovered self-induction. The battery, reversing switch, and ribbon-coil which he built are shown on the floor

returned to Copenhagen he built a large electromagnet after Faraday's design, which is still preserved at the Polytechnic Institute. Demonstrations with it were made by Oersted before the Royal Academy in Copenhagen during the two years 1847 to 1849, mostly in experiments with diamagnetism. Correspondence between the two savants covered the fields of compressibility of fluids, the confirmation of Mariotte's law, the liquefaction of gases, and the continuation of Chladni's patterns of sound produced on vibrating plates.

Oersted's paper on the acoustical figures, written in 1807 (published 1810), won for him the silver medal of the Royal Society of Sciences. It was an expansion of a letter to Ritter written in October 1804, and was in substance an electrical analysis of Chladni's figures. Oersted replaced Chladni's sand with a lighter powdered moss (lycopodium) resulting in a different pattern of figures from those of Chladni. Oersted had hoped to discover a relationship between parts of the acoustical figures with electrical charges, a further indication of his aim to correlate various manifestations of the forces of nature.

SCIENTIST AND CITIZEN

ABSORBING THE HONORS which came to him following the recognition of his discovery, Oersted threw himself into broadening the field of science education. He founded a society for the diffusion of scientific knowledge which has continued its mission into the present, and delivered lectures on science in the principal cities of Denmark. In 1823-24, he continued these lectures, in French. In 1828, he traveled to Norway and in the same year addressed a science society in Berlin. In the following years he visited Hamburg and in 1834 called upon the celebrated electricians and experimenters in Göttingen, Gauss and Weber, who had established a magnetic observatory there. Oersted later established a similar magnetic study at the Polytechnic Institute of Copenhagen on the ramparts of the city. France and England were visited by Oersted in 1836 and he was among those present at the meeting of the British Association at Southampton, where he listened to Sir John Herschel state that in science there was but one direction which the needle would take, when pointed toward the European continent, and that was toward his esteemed friend, Prof. Oersted. He knew not how to speak of him in his presence without violating some of that sanctity by which, as an individual, he was surrounded. "The electric telegraph," said Herschel, "and other wonders of modern science were but mere effervescences from the surface of this deep recondite discovery which Oersted had liberated, and which was yet to burst with all its mighty force upon the world. If we were to characterize by any figure the advantage of Oersted to science, we would regard him as a fertilizing shower descending from heaven, which brought forth a new crop, delightful to the eye and pleasing to the heart."

In England he came to know his experimenting colleagues Wollaston, Sir Humphry Davy, Michael Faraday, David Brewster, and Sir Roderick Murchison, the geologist. On returning home he became secretary to the Royal Society of Sciences in Copenhagen and a director of the Royal Polytechnic Institute which he had founded in 1829 as a result of the impressions made upon King Frederik VI; this college still continues as the primary source of engineering education for Denmark. Among the many honors granted him, the one he treasured most was the award of the Grand Cross of the Dannebrog in 1847.

A photo portrait of H. C. Oersted taken in the late 1840s. The first announcement of photography was made in 1839 and Oersted died in 1851. The above photograph was therefore taken during the first dozen years of the practice of photography

By every channel open to him, Oersted pursued his mission for science to which he was so deeply dedicated. His lectures, including a series of popular lectures to ladies, covered many fields of science. In 1829, he founded a monthly journal of literature to which he contributed many scientific essays. In 1852, in London these were subsequently published as a book in both Danish and English under the title *The Soul in Nature*. As a result of continued study, correspondence, and travel, he became fluent in German, French, Latin, and English in addition to his native Danish. He helped in the founding of a society for the promotion of the freedom of the press. In November 1850, the jubilee of the association of Oersted with the University of Copenhagen was celebrated as a national holiday. The King sent a deputation of ministers; professors and students joined the public in their congratulations to one of Denmark's greatest citizens. The government gave Oersted a country house near Copenhagen which had formerly been occupied by his old friend, the writer Oehlenschlaeger. A procession of students bearing torch-

lights proceeded to welcome him in his new home; they came singing verses in his praise as they marched.

But these honors were to be short-lived for on March 9, 1851, he died. The students bore his remains at night, again by torchlight, to the old university, chanting verses composed for this sad occasion. The King was represented in the funeral procession, and the crown prince, along with ministers and foreign ambassadors, showed the high esteem in which Oersted was held. Over 200,000 people from all walks of life joined in the procession.

As we face the nuclear age we can note the progress in the expansion of our knowledge of electromagnetism, and use it as an index of general science. Electromagnetism has become the major force in the generation, distribution, and use of electricity, without doubt our most useful aid.

No ancient seer could have prophesied man's ability to control such enormous blocks of power, such integration of networks covering such vast land areas, or put to such a wide order of usefulness. No dreamer could have anticipated obtaining such a delicacy of control, or the extension of man's limited faculties by acquiring electric devices like the telephone, the cinema, television, the electron microscope or radar astronomy. All had their beginnings in the discovery of electromagnetism.

Now there is scheduled a research project at the Massachusetts Institute of Technology's Magnet Laboratory to produce intense magnetic fields for helping in understanding the nature of matter and energy by learning even more about electricity and magnetism. Available to this $10 million research project will be 32,000 kw of electric power, enough to provide the full needs of some cities.

Oersted's hunt for interrelationships between the forces of nature has been picked up by the younger investigators in succeeding generations. Such hunger for greater knowledge continues to distinguish man from his fellow creatures.

REFERENCES

1. Essai Theorique et Experimental sur le Galvanisme, Jean Aldini. Paris, France, 1804; 8°, 2 vol., plates.

2. Pioneers of Electrical Communication, Rollo Appleyard. London, England, 1930, chapter vi; 34 pp., ports, plates.

3. Eloge Historique de Jean-Christian Oersted, Elie de Beaumont. Paris, France, 1863; 4 2, 48 pp.

4. A history of Electric Telegraph to the Year 1837, J. J. Fahie. London, England, 1884; 8°, 19, 542 pp.

5. Les Marveilles de la Science, Louis Figuier. Paris, France, c. 1870; vol. 1, cr. 4°, 6, 743 pp., replete with illustrations.

6. Die Elektricitaet und ihre Anwendungen, L. Graetz. Stuttgart, Germany, 1895; 4°, 12, 511 pp.

7. Historical Account of the Introduction of the Galvanic and Electro-Magnetic Telegraph into England, J. J. Hamel. London, England, 1859; 12°, 79, 16 pp.

8. Hans Christian Orsted, En kort Levnedsskildring, M. C. Harding. Kobenhavn, Denmark. 1920; 8°, 16 pp.

9. H. C. Orsteds Opdagelse of Elektromagnetismen, Helge Holst. Kobenhavn, Denmark, 1920; 8°, 16 pp. (on the discovery of electromagnetism).

10. Manuel du Galvanisme, Joseph Izarn. Paris, France. 1804; 8°, 4, 12, 304 pp., plates.

11. History of Electro-Magnetism and its Application to the Telegraph, C. A. Joy. *Leslie's Monthly*, Aug. 1878, pp. 241-255.

12. Hans Christian Oersted. Et Blad af Fysikens og Kemiens Historie, Laurits Lauritsen. Kobenhavn, Denmark, 1909; 11, 8°, 135 pp., ports. (biographical notes and a selection from Oersted's poems; Danish version of the "Experimenta" is given.

13. Prominent Danish Scientists, V. Meisen. Copenhagen, Denmark, 1932, pp. 89-93.

14. A Century of Electricity, T. C. Mendenhall. London, England, 1887, pp. 67-110.

15. (See Oersted, Scientific Papers), Kerstine Meyer.

16. Elogi di l'Uomini Illustri Italiani, Melchiorre Missirini, Forli, Italy, 1840; 4°, 50 biographies with portraits, including Romagnosi.

17. Pioneers of Electricity, John Munro. London, England. 1890, pp. 141-158; 8°.

18. Om overensstemmelsen mellem de elektriske Figurer og de organiske Former, Dr. (Hans Christian) Oersted. Kobnhavn, Denmark, 1805; 12°, 22 pp., in the Skand. Lit. Selsk. Skrift.

19. Betragtninger over Chemiens Historie, en Forelaesning, *Ibid.* 1807; in Det skandinaviske Litteraturselskabs Skrifter, Kjoebenhavn, 1807, pp. 1-54.

20. Videnskaben om Naturens almindelige Love, *Ibid.* 1809; 8°, 30, 378 pp.

21. Recherches sur l'Identite des Forces Chimiques et Electriques, *Ibid.* Paris, France, 1813; 8°, 6, 20, 260 pp. (translated by M. de Serres).

22. Experimenta Circa Effectum Conflictus Electrici in Acum Magneticam, *Ibid.* Hafniae, July 21, 1820; 4°, 4 pp. with certification of authenticity by the Polytekniske Laereanstalt.

23. *Ibid.* Experiences sur l'effet du conflict electrique sur l'aiguille aimantee, in Annales de Chimie et de Physique, Paris, France, 1820, vol. 14, pp. 417-426.

24. *Ibid.* La Decouverte de l'Electromagnetisme faite en 1820 par J. C. Oersted, Copenhague, 1920; 4°, 46 pp. Preface by A. Larsen; facsimiles of the first Latin, French, Italian, German, English, and Danish announcements.

25. *Ibid.* Zur Entdeckung des Elektromagnetismus. Abhandlunger von Hans Christian Oersted und Thomas Johann Seebeck. (1820-1821), Leipzig, Germany, 1895; 8°, 84 pp. Ostwalds' Klassiker, no. 63.

26. Meddelelse om Electromagnetismens Opdagelse, *Ibid.* In the Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger, May 1820-May 1821, pp. 12-21. Contains the earliest account of the discovery of electromagnetism after the initial announcement of July 1820.

27. Thermo-Electricity, *Ibid.* Edinburgh Encyclopaedia, Edinburgh, Scotland, 1830, ed., David Brewster; 4°, vol. 18, pp. 573-589, 2 plates.

28. Ueber die Wesenseinheit des Erkenntnissvermoegens in dem ganzen Weltall, *Ibid.* Kiel, Germany, 1846; 4°, 16 pp.

29. Die Naturwissenschaft und die Geistesbildung, *Ibid.* (Translated by K. L. Kannegiesse, Leipzig, Germany, 1850; 8°, 16, 170 pp.

30. Aanden i Naturen, *Ibid.* Kjobenhavn, Denmark; 8°, 2 vols.

31. The Soul in Nature, with Supplementary Contributions, *Ibid.* London, England, 1852. (Translated by L. and J. B. Horner).

32. Der Mechanische Theil de Naturlehre, *Ibid.* Braunschweig, 1851; 8°, 21, 349 pp.

33. Kleinere Schriften, *Ibid*, Leipzig, Germany, 1855; 8°, (2 vols. in 1 on science, mythology and philosophy).

34. Gesammelte Schriften, *Ibid*, Leipzig, Germany, 1850-1; 8°, 4 vols. in 1; port., plates.

35. H. C. Oersted, Scientific Papers, Kirstine Meyer. Collected works in the language of their publication. Copenhagen, Denmark, 1920; 4°, 3 vols., ports., figs. (Includes a biography of 166 pages).

36. Breve fra og til Hans Christian Oersted, Mathilde Oersted. Kjobenhaven, Copenhagen, 1870; 8°, 2 vols., port.

37. Correspondence de H. C. Oersted avec divers Savants publiee par M. C. Harding. Copenhague, Denmark, 1920; 4°, 2 vols. facsimiles.

38. H. C. Oersted's Slaegt, H. C. Oersted III. Copenhagen, Denmark, 1960. (The genealogy of the family from 1582 to the present.)

39. The Foundation of Electromagnetism, George Sarton. 1820, ISIS, vol. 34, June, 1928, 10 pp. Portrait of Oersted by Bearentzen, facsimile of the "Experimenta," etc., 1820, and the English translation in Thompson's "Annals of Philosophy," 1820.

40. H. C. Oersted, Discoverer of Electro-Magnetism, Jorgen Schroeder. Copenhagen, 1952.

41. Elements of Electro-Metallurgy, Alfred Smee. London, 1843, p. 297.

42. Persistent Errors Regarding Oersted's Discovery of Electromagnetism, R. C. Stauffer. ISIS, vol. 44, Dec. 1953, pp. 307-310.

43. Speculation and Experiment in the Background of Oersted's Discovery of Electromagnetism, *Ibid.* ISIS, vol. 48, Mar. 1953, pp. 33-50.

44 An Historical Sketch of Henry's Contribution to the Electro-Magnetic Telegraph, W. B. Taylor. Washington, D. C., 1879; 103 pp.

45. The Electromagnet, S. P. Thompson. London, England, 1890, 4, 4, 100 pp. inscribed to Sir William Crookes.

All of the books and pamphlets listed in this bibliography are in the possession of the Burndy Library; in addition, the library has a large collection of general reference material in the history of electricity and magnetism.

Current Asymmetry in Resistance-Reactance Circuits—II

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THE value of the ratio of asymmetric to symmetric rms current is an important parameter in the evaluation of asymmetric current effects on electric protective devices. For the simple resistance-reactance circuit (Fig. 1), the ratio of asymmetric to symmetric rms current, for the first current loop, for different values of power factor of the circuit, and for varying points of short-circuit initiation on the voltage wave has been evaluated accurately. The instants of short-circuit initiation on the voltage wave which lead to the maximum values of the ratio of asymmetric and symmetric rms current for different power factors of the circuit can also be found.

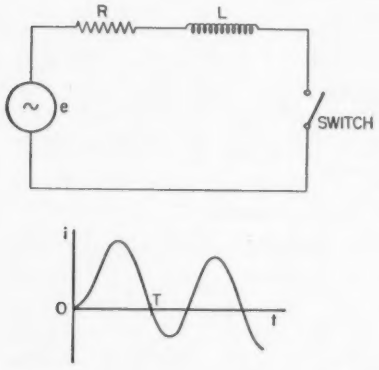

Fig. 1. Circuit diagram and instantaneous current *i*. Current zeros at $t = 0$ and $t = T$

The large number of computations involved and the solution of transcendental equations suggests the use of a digital computer for the determination of the current ratio. Fig. 2 shows some of the typical curves, obtained from the output of the computer and giving relations between power factor of the circuit and current ratio for various values of ϕ. At the instant the short circuit occurs, ϕ is the angle by which the voltage phasor has advanced from its position at zero instantaneous value. Fig. 3 shows the maximum current ratios at different power factors and the switching angle ϕ at which each maximum occurs.

The maximum value of the current ratio is 1.7662; it occurs when the circuit power factor is 0.005 and the angle ϕ is 12 degrees. The curves reveal that the maximum value of the current ratio for different power factors is never less than unity and is equal to unity at power factor 0.85 for an angle ϕ equal to 30 degrees; when the power factor is greater than 0.6 the effect of asymmetry of the current is small and the maximum value of the current ratio is between 1 and 1.1. The curves shown in Fig. 3 should be useful in setting up tests for determining the maximum interrupting ability of power fuses and in the application of power fuses in order to utilize their maximum interrupting capability.

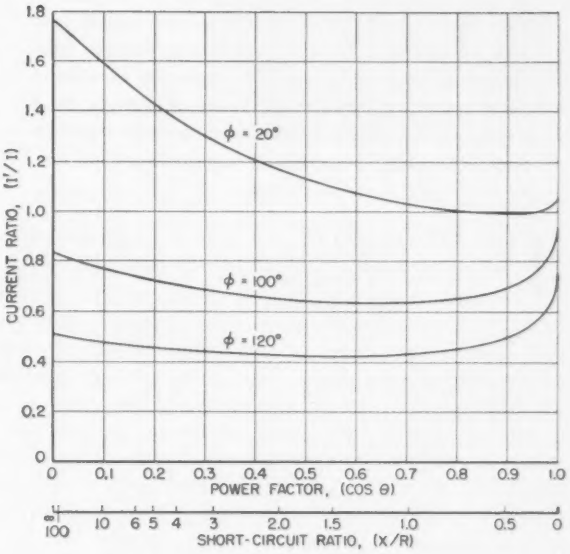

Fig. 2. Ration curves for various angles ϕ

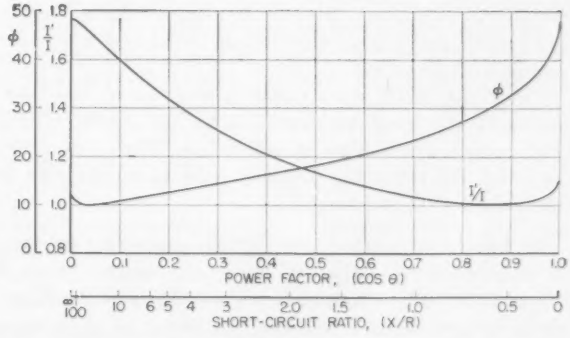

Fig. 3. Maximum current ratio at different short-circuit ratios, and angle ϕ at which this maximum occurs

Digest of paper no. 61-783, recommended by the AIEE Switchgear Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Ithaca, N. Y., June 18-23, 1961. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1961.

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A Solid-State Electronic Control System for Industrial Processes

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A control system must be reliable to the extent that component failure is infrequent, signal loss and component failure can be monitored, and servicing and check-out are easy. An electronic system having these features as objectives, and designed for adaptation to automatic start-up and computer-supervised operation, is described.

THE COMPLEXITY and critical control requirements of modern industrial processes make it desirable to consider control of the various process loops on a system-wide basis. This approach requires that process controllers be considered not as separate single-element controllers, but as computing devices designed to fulfill specific mathematical functions.

The most frequently used electronic process controller is a device giving proportional plus integral and sometimes derivative action, packaged with a transfer station in a panel-mounted assembly. This philosophy is well adaptable to systems which contain but one transmitter, one controller–selector station, and one final control element. However, for systems of greater complexity, the single-element controller–selector station lacks flexibility, because it usually requires more controllers and several varieties of linear and nonlinear computing elements.

Once the basic operational requirements are met, probably the most important factor in control system and component design is reliability. With reliability in mind, the following practices have been followed in the system described here:

1. The circuit techniques embody up-to-date designs, as well as reliable industrial grade components, derated by at least 50%. Vacuum tubes and gaseous discharge devices have been eliminated in favor of solid-state components. In addition, the use of components having moving parts is kept to a minimum.

2. Manual-to-automatic and automatic-to-manual transfer are accomplished instantaneously without requiring careful signal balancing by the operator, thus avoiding system upset. Additionally, wires that interconnect the control loop are not brought into the selector station. If the cable between the selector station and control cabinet is cut, the system will go to manual operation, holding the final operator where it was previous to the accident.

3. Operation of controller amplifiers can be continuously monitored by an alarm circuit operated from the controller amplifier summing points, whose voltages should normally be zero. If they are not, the alarm monitor throws the system to manual or locked operation.

4. To allow easy servicing and replacement of components, each functional unit in the control system is a plug-in device with accessible input and output check points. Interconnecting cables are not used because they are a potential source of trouble; Blue Ribbon connectors are used exclusively.

SIGNAL LEVELS

IN THE DESIGN of an electronic control system, it is necessary at an early stage to choose a signal for use between the transmitter and the control room, and between the control room and the final element. Three types of control signals in common use are alternating voltage, direct current, and direct voltage. The alternating-voltage types are unique in their simplicity and their low cost in systems using movable-core transformers as position measuring devices. They were not chosen as the standard signal in the system described here, since electrostatic and magnetic pickup into the measuring wires from nearby power wires, as well as line capacitance, causes out-of-phase voltages to be induced in the transmission lines, thus degrading the transmitted signal. Although some of these limitations can be overcome by shielding, the advantages offered by inexpensive unshielded wiring seem predominant.

Several commercial electronic control systems use direct current as the standard signal. The maximum and minimum values of current are generally in the range of 1 to 5 milliamperes, although some zero-based signals are available.

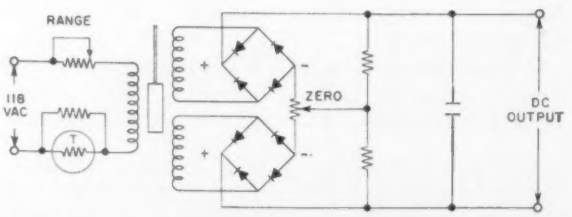

Fig. 1. Schematic diagram of movable core transformer and demodulator

Revised text of conference paper CP61-174, recommended by the AIEE Recording and Controlling Instruments Committee for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 29–Feb. 3, 1961.

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Investigation of systems using a current standard signal shows that in most cases this current must produce a magnetomotive force, either to rebalance a force or motion balance transmitter, or to be applied to a torque motor in an electromagnetic structure to actuate a pneumatic or hydraulic final element.

The control system described here uses direct voltage as a standard transmission signal. The pressure, flow, and level transmitters used presently in the system utilize a movable-core transformer as a position transducer. Since this transformer is a voltage-producing device, no amplification is required at the transmitter and there is no need for a current to provide a rebalancing force. When force balance transmitters are used in the system, these can have their current outputs converted to a voltage by a dropping resistor.

Torque motors will continue, of course, to be used in systems which utilize electropneumatic or electrohydraulic control drives. While voltage and current signals are both adaptable to these, the author feels that in a few years all-electric modulating control drives will find wide use. These drives have voltage position tiebacks which are compared with the output voltage signal from the control room. Hence, when electric drives are used, the necessity for a current signal in this part of the control loop is eliminated and a voltage signal preferred.

Inside the controller, reset and rate action can easily be accomplished with voltage signals, as is done in analog computers; the same is true for signal limiting, auctioneering, and most of the other computing functions. For this reason, practically all present electronic controllers, as well as all analog computers, use direct-voltage signals internal to the controllers to obtain different control actions. A voltage system appeared to have certain advantages in reliability, since recorders, relays, and other auxiliary devices are placed across the transmitter signals rather than in series with the loop.

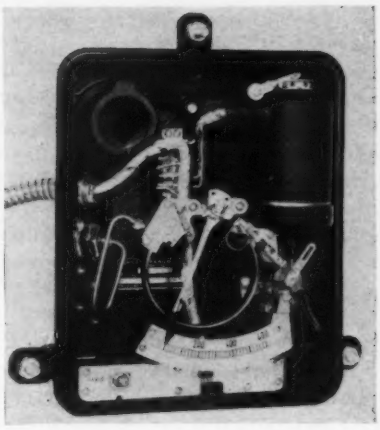


Fig. 2. Pressure transmitter with transformer and demodulator

Once the type of signal to be used had been chosen, it became necessary to determine a signal range and zero suppression. From the standpoint of controller zero drift, which is an inherent property of the controller amplifier, it is desirable to keep the voltage range as high as possible; the higher the signal range, the lower the zero drift as a percentage of full range. Since with the transistor controllers used the input drift observed over wide temperature ranges is of the order of 50 millivolts, a 50-volt range is normally used, establishing a zero drift of about 0.1%. Alternate ranges could be used with corresponding changes in accuracy.

A zero-center signal was preferred as a standard because it affords better accuracy and utilization of equipment. Since the movable-core transformers and signal amplifiers for thermocouples, resistance thermometers, etc., are all 60-cycle carrier-type devices, phase-sensitive output demodulation results in equally accurate d-c output on either side of zero. Such devices are also most linear and reproducible around the zero point. In addition, the operational amplifiers used in the controllers

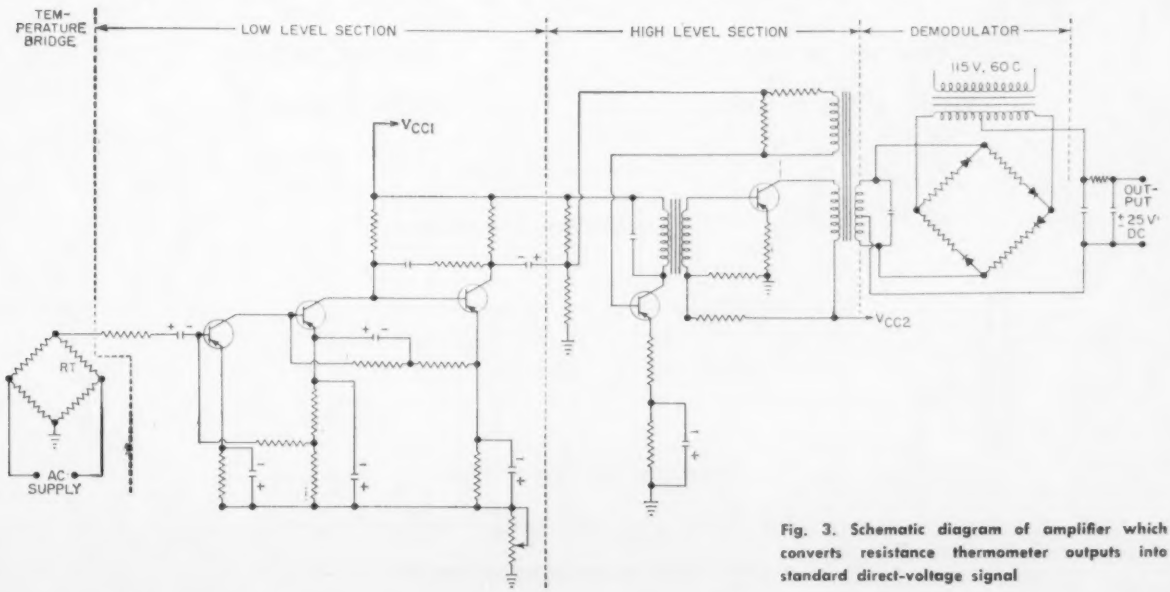


Fig. 3. Schematic diagram of amplifier which converts resistance thermometer outputs into standard direct-voltage signal

inherently produce outputs which vary equally on both sides of zero. Thus, operation at ranges other than zero center would involve biasing various components, resulting in greater equipment complexity and no accuracy improvement. Where it is desired to monitor a signal for loss of line by distinguishing between signal zero and open line, the transmitter output can be biased to produce a composite elevated voltage range, the set point adjustment in the control room being calibrated to the same range, in order to match the transmitted output.

TRANSMITTERS AND SIGNAL CONVERTERS

TRANSMITTERS used in industrial process controls can usually be classified into two types: (1) those which produce mechanical position output, and (2) those which yield voltage or current outputs.

Flow, level, and differential pressure transmitters use movable-core transformer position transmitters giving electric a-c outputs which are demodulated by silicon-diode full-wave bridges to produce the standard —25- to +25-volt d-c signal. Stability of these transformer demodulators is ±0.25% over a 40 to 140 F range.

The movable-core transformer and demodulator are shown schematically in Fig. 1. Each secondary winding is applied to a separate full-wave demodulator, the two outputs then being subtracted from one another and filtered. Fig. 2 shows a typical pressure transmitter with the transformer and demodulator. Temperature compensation is accomplished by a thermistor–resistor network on the primary side of the transformer.

Transmitters such as thermocouples, resistance thermometer bridges, and gas analyzers produce low-level voltages which are amplified by solid-state amplifier/

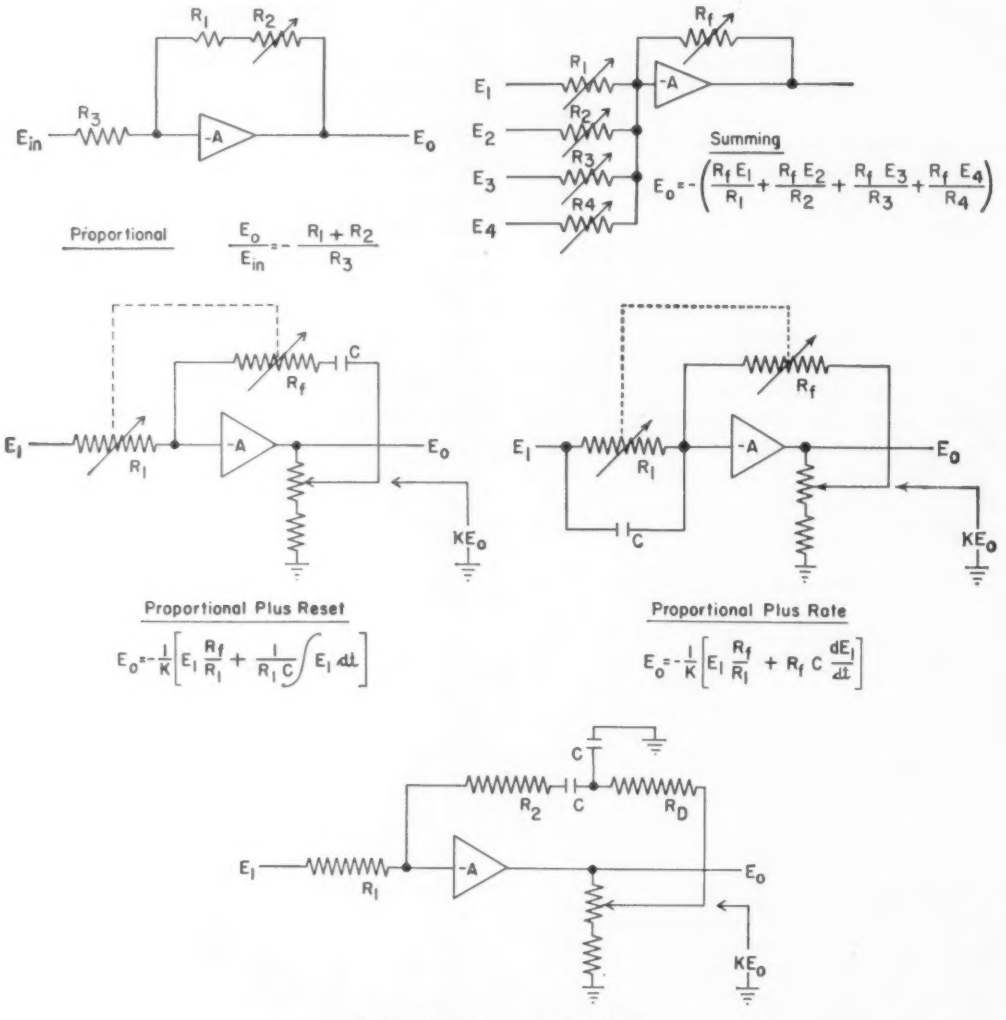


Fig. 4. Schematic diagrams of typical action units

demodulators, to produce highly linear —25- to +25-volt outputs. Fig. 3 shows a schematic diagram of an amplifier used to convert resistance thermometer bridge 60-cycle outputs to the standard direct-voltage signal. The amplifier consists of three sections. The low-level section has three direct-coupled transistor amplifier stages in which the bias of the first two stages is obtained from the emitter of the succeeding stage, for gain and bias stability. An emitter resistor common to all three stages is used to provide high input impedance, to stabilize the gain, and to provide a range adjustment. The second section consists of two transformer-coupled stages, feedback stabilized by a tertiary winding on the output transformer to provide gain stability and temperature compensation. The a-c output is applied to a ring demodulator whose direct-voltage output is filtered with a 2-stage *R-C* filter. The amplifier is linear to within 0.5% of full range with wide temperature changes, and has an input impedance of more than 2 megohms.

Note that the outputs of all transmitters have floating grounds; that is, the ground is established at the controller rather than at the transmitter. Thus, it is possible to connect the transmitter so its output can impose either direct or inverse action on the final element.

CONTROLLING DEVICES

THE CONTROLLERS used in the system utilize d-c operational amplifiers with the proper input and feedback resistances and capacitors to produce the desired control actions. Controllers are classified into control action units such as rate unit, reset unit, proportional, subtracting, or summing units, or combinations thereof. Schematic diagrams of typical action units are shown in Fig. 4. The controllers have adjustable gains of 0.5 to 20, reset rates of 0.1 to 50 repeats per minute, and rate times of 0.04 to 10 minutes.

The transistorized controller is shown schematically in Fig. 5. It uses a 60-cycle carrier-type amplifier, thus minimizing the number of transistors by not requiring an oscillator. The summing-point voltage, or difference between input and feedback voltage, is changed to 60 cycles a-c by a full-wave ring modulator using low-leakage diodes. The alternating voltage is amplified by a 5-stage transistorized amplifier, comprising three stages of direct-coupled amplification, one *R-C* coupled stage, and one stage of transformer coupling. The amplified a-c output is changed to phase-reversing direct current by a full-wave ring demodulator. The amplifier has sufficient output to supply ±25 volts to a load of 5,000 ohms continuously, and has an open loop d-c gain of approximately 600. Filtering is employed to make the controller immune to 60-cycle voltages which may be induced in the input wires. The drift of the amplifier between 40 and 140 F is approximately 1 millimicroampere referred to the input, corresponding, under worst conditions, to about 50 millivolts or 0.1% drift.

A summing-point monitor, shown by Fig. 6, can be used with the controllers to indicate malfunction of the operational amplifier or its feedback loop. It consists of a high-gain amplifier with a positive-feedback loop, the feedback being applied across two low-leakage diodes, *D1* and *D2*. The diodes are connected in series with a high-value resistance to the summing point, and are a-c coupled through a capacitor to the input of the monitor amplifier. When the summing point is near zero, indicating proper amplifier operation, the diodes have a very high resistance. Thus, regenerative feedback may be applied to the amplifier, causing it to oscillate. The oscillations, the frequency of which is determined by a twin-T circuit within the amplifier, are demodulated and energize a relay as long as the summing-point voltage is nearly zero. If a controller failure occurs, the

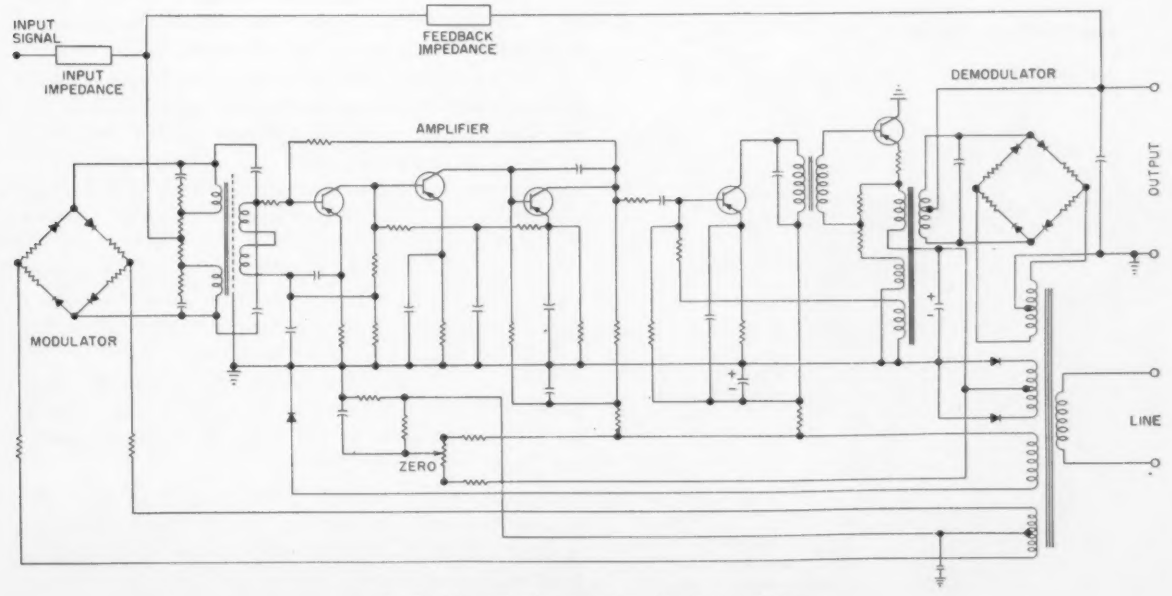


Fig. 5. Schematic diagram of transistorized controller

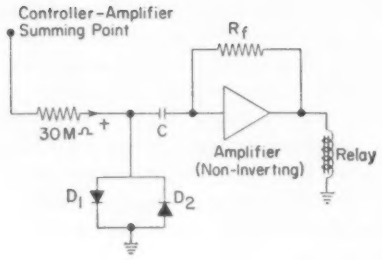


Fig. 6. Summing-point monitor

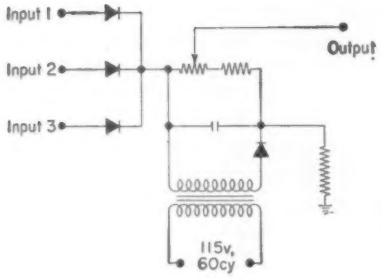


Fig. 7. Auctioneering circuit

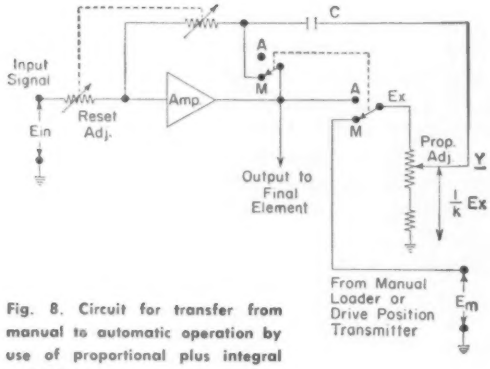


Fig. 8. Circuit for transfer from manual to automatic operation by use of proportional plus integral controller

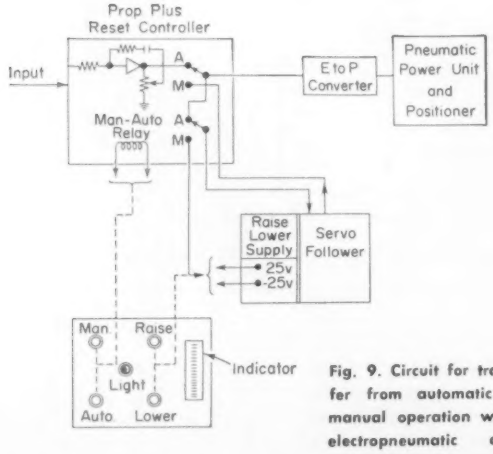


Fig. 9. Circuit for transfer from automatic to manual operation when electropneumatic converter is used

summing point will deviate from zero, causing one of the diodes to conduct. The regenerative feedback voltage is then nearly short-circuited out, the amplifier stops oscillating, and the monitor relay drops out, causing either alarm or transfer to manual operation. If the monitor itself fails, the relay drops out.

It is often necessary to select automatically the largest or smallest of a number of quantities. This is done by an auctioneering circuit, shown in Fig. 7. The inputs to be auctioneered are placed in series with silicon diodes, the cathodes of which come to a common point. The largest (most positive) signal causes its diode to be forward biased, thus reverse biasing all the other diodes, and permitting only the largest input signal to reach the output. The voltage source shown is used to overcome the forward drop of the diodes, and to extend the range of the auctioneer down to —25 volts.

SELECTOR STATIONS

Electronic process control systems contain manual–automatic transfer stations, to permit the control of the measured variable to be taken over from the automatic control system by a human operator.

Transfer stations normally require a human operator to make a manual balance by turning a knob and watching a pointer before the manual–automatic or automatic–manual transfer can be made. This is necessary to prevent an upset in the process caused by a step input to the final element. In completely automatic processes, in which transfer of manual to automatic and automatic to manual may be done by data-handling systems or process-control computers, it is required that the human operator be eliminated from the transfer operation, at the same time avoiding process upsets.

The control system described here uses selector stations which are adapted for automatic plant operation by providing the following characteristics:

1. They allow instantaneous transfer in both directions without process upset, and require no balancing or pointer comparison prior to transfer.

2. In applications where automatic start-up or automatically sequenced operations are required, it is not necessary to have a human operator present to transfer in either direction. Transfer can be accomplished by transmitters or computed signals reaching certain levels, completion of a sequence of operations, or other automatically initiated impulses.

3. The only wires brought to the remotely located selector station are transfer-initiating wires. No control signal intelligence is brought to the selector station, except for indication where required.

4. In case of controller failure, the system can automatically be thrown to manual operation, thus causing the drive to remain locked until the operator pushes the "raise" or "lower" button.

The circuit for transfer from manual to automatic operation, using a proportional plus integral controller, is shown in Fig. 8. In order that process upsets may be avoided, it is necessary that immediately after transfer to automatic operation, the signal to the final operator

be the same as the drive position or manual loader signal was immediately before transfer. The transfer function of such a controller, when on automatic, is

$$\frac{E_o}{E_{in}} = -K\left(1 + \frac{1}{ST}\right) = -K - \frac{K}{ST}$$

where K is the proportional gain and T the reset time constant.

When the system is on manual, the contacts on the manual–automatic switch cause the controller to be a proportional controller with a 1-to-1 gain and no reset, so that its output is merely $-E_{in}$. The right side of the reset capacitor receives the manual loader or drive position voltage, attenuated by the gain potentiometer, so that the voltage at this point from ground is E_m/K. The voltage on the left side of the capacitor is $-E_{in}$. The total voltage across the capacitor is then

$$E_c = \frac{E_m}{K} - (-E_{in}) = \frac{E_m}{K} + E_{in}$$

The total voltage from point Y to the summing point (virtual ground) immediately after switching is

$$-E_{in} + \frac{E_m}{K} + E_{in} = \frac{E_m}{K}$$

Therefore, the output of the controller immediately after switching is

$$E_o = \frac{E_m}{K} \times K = E_m$$

This shows that after switching, the controller output equals the manual loader voltage, resulting in bumpless transfer.

The method of transfer from automatic to hand depends upon whether electric or pneumatic drives are used. When electric control drives are used, transfer to manual is accomplished by pushing the "manual" button or otherwise initiating the impulse to go to manual. The drive is then locked in place by a brake, which is small in a unit having gear reduction, since the braking is accomplished on the high-speed side. The brake will remain engaged until a "raise" or "lower" impulse is initiated, at which time it moves for the duration of the impulse.

When pneumatic drives are used, conversion from an electric to a pneumatic signal is accomplished by an electropneumatic converter located at the control drive.

Transfer to manual is explained with the aid of Fig. 9. A transistorized servo follower is used to allow the manual loader voltage continuously to follow the controller output when on automatic, so that the voltage output of a motor-driven potentiometer on the follower duplicates the controller output. When the system is switched to manual, the servo follower, which now is disconnected from the controller but whose output holds the voltage present just before transfer, acts as a manual loader for the drive. The servo becomes locked in place and its position, and hence the drive position, cannot be changed until the "raise" or "lower" push

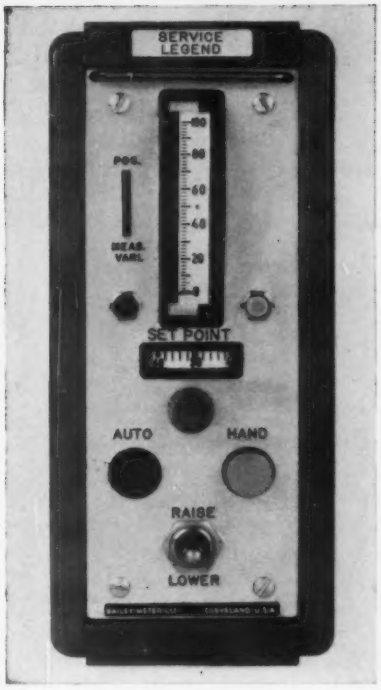


Fig. 10. Selector station

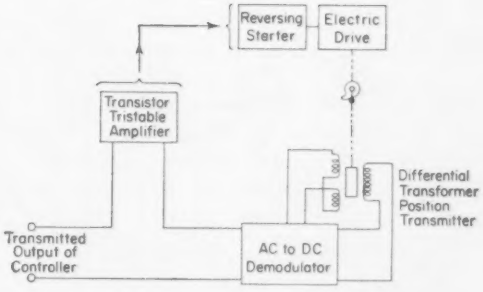


Fig. 11. Block diagram of electric drive servo system

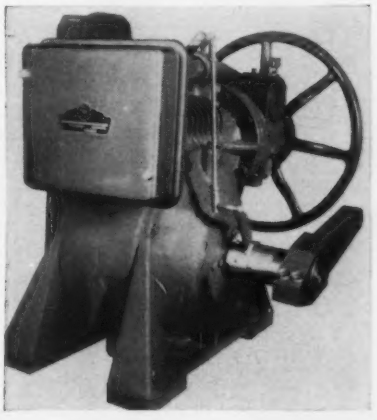
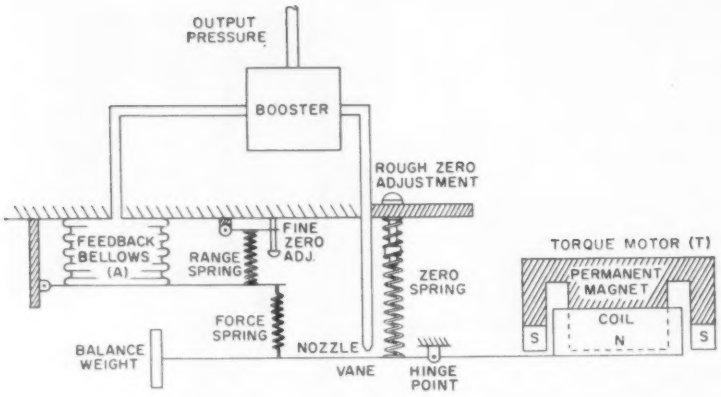


Fig. 12. Typical gear motor drive installation



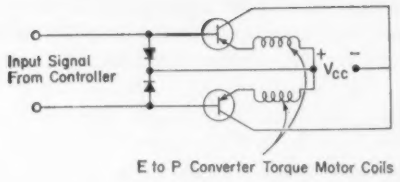


Fig. 13 (left). Schematic of force balance electric-to-pneumatic converter. Fig. 14 (above). Transistorized buffer amplifier for use with electric-to-pneumatic converter

button at the selector station is pressed, or equivalent computer impulses are obtained. When this occurs, the input to the servo follower is connected to a voltage source of reversible polarity to drive the servo follower up or down, changing the position of the drive. The front of a typical selector station is shown in Fig. 10.

FINAL OPERATOR ACTUATORS AND AMPLIFIERS

Two types of final operators are designed for the system: contact-operated constant-speed operators and pneumatic operators. Electric control drives are of the gear motor type. They use worm gear reductions and are self-locking in case of power interruption. The controller output is compared against a drive position tieback signal derived from a differential transformer and demodulator, as shown in Fig. 11. The drive characteristic can be linearized with a cam. The difference between these signals is fed into a transistorized tristable amplifier which operates a raise or lower relay, as called for by the controller output signal. The amplifier consists of a diode full-wave ring modulator, a single-stage a-c amplifier operating with a 60-cycle carrier, and a phase-sensitive discriminator. A dead-band adjustment is provided in the amplifier to prevent hunting. A typical gear motor drive installation is shown in Fig. 12.

When pneumatic drive or valve operators are employed, the voltage tieback approach is not used. Instead, the controller or manual loader output voltage is applied to a force-balance electric-to-pneumatic converter, shown schematically in Fig. 13, located near the drive. The input signal is applied to a torque motor *T* which produces a small motion of a coil in a magnetic circuit biased by a permanent magnet. This deflection causes a change in the vane-nozzle distance, changing the nozzle back pressure, which is amplified by a pneumatic booster to produce a new output air pressure. This output pressure is also applied to feedback bellows *A* to restore the original vane-nozzle relationship. Because of the high gain of the booster, the change in vane-nozzle distance is very small. A transistorized buffer amplifier is used to amplify the output of the selector station for application to the electric to pneumatic converter. This amplifier consists of a single-stage push-pull common collector stage, designed to operate from the −25- to +25-volt signal, and is shown in Fig. 14.

Fig. 15. System cabinet, front view

PHYSICAL DESIGN OF SYSTEM CABINETS

As previously stated, the nature of modern processes requires that control equipment be considered on an integrated or system-wide basis. The physical means of mounting the equipment must be designed in keeping with this philosophy.

Fig. 15 shows a number of plug-in modules installed in a system cabinet which houses all control-room-mounted equipment except the selector stations. All modules have their supply and output wires brought to a centralized interconnection center, called the wiring plane, at the rear of the cabinet. In addition, modules have input and output check points brought to the front.

In computer supervision of process control systems it is often necessary to incorporate digital data-handling equipment or servo analog computers into the total control or computing loop. With this in mind, the system cabinet was designed to receive combinations of analog control equipment, data-handling modules, and analog servo computation equipment for the calculation of heat rates and other efficiency criteria.

A New Current-Limiting Motor-Starter Fuse

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HIGH-voltage motor-starter fuses, which afford short-circuit protection, are used in conjunction with a contactor and relays co-ordinated to protect the motor from excessive long-time overloads.

Desirable characteristics of current-limiting fuses which make them particularly suitable for this usage are: (1) The interruption of large available fault currents without any expulsion of gases or solid materials, and without violence or noise; (2) Limitation of peak currents and energies to values less than that represented by the available short-circuit current; (3) Absence of any moving parts required to effect interruption.

There are additional requirements of motor starting which demand that special design features be incorporated. A high thermal capacity is necessary to permit the fuse to ride through high initial starting currents which may be as great as six times the full load rating. A motor-starting fuse should be fatigue-proof; that is, repeated flexing of the elements, in response to the heating caused by starting currents, must not damage or break the elements. The fuse should have good low-current interruption characteristics to permit successful co-ordination with the contactor and relays which protect the motor from excessive long-time overloads.

For effective operation as a current-limiting interrupter, the fuse must melt on the steeply rising slope of the current wave before the first current peak of the alternating wave is reached. The rate of rise of this current and the arc voltage generated and maintained by the fuse are the essential ingredients of its successful operation. The arc-voltage characteristics of various fusible elements operating in a variety of environments were studied through the use of cathode ray oscillograms of surge generator discharge. The rate of rise of the current discharge and the peak currents permitted were accurately controlled by discharging the surge generator through the test sample and a series inductance of adequate and adjustable capacity. This approach proved very valuable in the development of a high-current interrupting means.

The study of low-current characteristics was expedited by utilizing each sample twice. Minimum melting characteristics were obtained at very low voltages which would fail to initiate any significant amount of element burn-back. The development samples could then be again used to determine clearing characteristics at high voltages. This was possible as the impressed high voltage would immediately flash over the short open gap in the elements. The interrupting abilities for currents even less than the fuse minimum melting could be checked in this manner.

Still to be considered at this stage of the development was the effect of fatigue loading on a fuse built along the lines indicated by the preceding work. Accordingly, a load-cycling device was constructed by means of which the fuse could be heavily loaded for some seconds (representing the starting time for a motor) after which the current would fall to and be maintained at the full load rating of the fuse for a number of minutes. This current would then be discontinued and the fuse allowed a brief rest of several minutes before commencement of the next cycle. All times and currents could be readily varied to permit a wide range of cycling tests. A typical duty cycle is shown in Fig. 1.

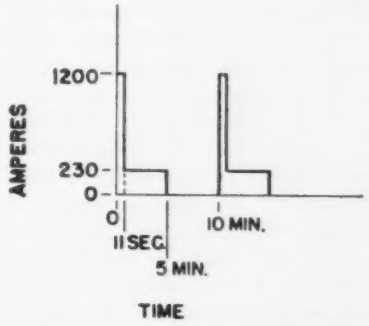

Fig. 1. Typical simulated motor-starting duty cycle.

It was found that a straight fusible conductor running parallel to the axis of the fuse tube performed quite poorly from the standpoint of fatigue. Investigation indicated a pronounced flexing of the fuse elements which occurred in response to the expansion and contraction of the silver strap as the fuse loading was varied. This flexing would localize at one or two spots in the element, and would eventually cause the conductor to physically fracture. Modifications of the fuse assembly were made where the element was wound in a helix. Other approaches tested included physically supporting the element, or subjecting it to various types of pre-bending operations. The most successful and practical means of elimination of fatigue failure of the elements was achieved by a uniform and symmetrical pre-bending where each bend, occurring at ¼-inch intervals along the length of the element, was to an included angle of approximately 120 degrees. This pre-bending apparently causes the expansion occurring in the element during heavy loading to be uniformly distributed along the current-carrying member, with the result that the variation in stress intensities at any one point of loading is kept within the endurance range of the metal, and the element does not break.

Digest of paper 61-131, recommended by the AIEE Switchgear Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 29-Feb. 3, 1961. Published in AIEE *Power Apparatus and Systems*, April 1961, pp. 89-94.

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Concrete and Abstract Quantities and Units after Rationalization

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ASSOCIATE MEMBER AIEE

The discussion, begun by F. B. Silsbee,[1] is continued on the question whether the revealed differences between concrete and abstract quantities and units require separate names to avoid any ambiguity. The origin of these differences is clarified but the author contends that new names are not justified.

IN AN article entitled "Does Rationalization Change Units?" F. B. Silsbee[1] justified the following conclusions: "The process of total rationalization (1) does change the coefficients in certain measure equations; (2) does change the coefficients in the corresponding quantity equations; and from the "classic" point of view, (3) does not change any concrete quantity; while from the "modern point of view it (5) does change certain abstract quantities, but (6) does not change any abstract units." One can but support these concise statements which give a striking description of differences in opinion caused by the fact that concrete and abstract quantities and units do not correspond exactly before and after rationalizing electromagnetic field equations.

Finally, Silsbee regrets that distinction was not recognized long ago, and he asks for new names. The aim of the following is to make clear where the differences between concrete and abstract quantities and units come from, and to show that new names are not needed.

A SHORT SURVEY OF QUANTITY CALCULUS

EQUATIONS THAT DO NOT REFER to pure numbers alone have been in use for many years. They are well known as the following may prove.

The United States yard is often given by

$$1 \text{ U.S. yard} = \frac{3{,}600}{3{,}937} \text{ meter} \qquad (1)$$

In the cgs (centimeter-gram-second) system of units, the unit of force is connected to the three basic units: centimeter (cm), gram (gm) and second (sec) by the expression

$$1 \text{ dyne} = 1 \frac{\text{gm} \times \text{cm}}{\text{sec}^2} \qquad (2)$$

The unit of resistance is sometimes expressed by the units of length, mass, time, and electric charge as follows:

$$1 \text{ ohm} = 1 \frac{\text{watt}}{\text{ampere}^2} = 1 \frac{\text{kilogram} \times \text{meter}^2}{\text{coulomb}^2 \times \text{second}} \qquad (3)$$

The relation between electric charge or electric quantity and current and time has been written as

$$\text{quantity} = \text{current} \times \text{time} \qquad (4)$$

Very often one finds in the literature equations such as the following, giving the velocity of light in vacuo:

$$c = 2.99792 \times 10^8 \text{ m per sec} \qquad (5)$$

For the calculation of the area of a rectangle, the following series of equations may be used:

$$\begin{aligned} &4 \text{ feet} \times 2 \text{ yards} = 8 \times 1 \text{ foot} \times 1 \text{ yard} = \\ &24 \times 1 \text{ foot} \times 1 \text{ foot} = 24 \times 12 \text{ inches} \times 12 \text{ inches} = \\ &3{,}456 \text{ square inches} \end{aligned} \qquad (6)$$

In equation 1 the sign of equality can not be justified by the numbers 3,600 and 3,937 alone; the parts "U. S. yard" and "meter" are also necessary; they form constituent elements of the equation. In equation 2 the numbers 1 might not be written, the essential parts being the unit name, dyne, and the unit symbols gm, cm, sec. In equation 3 the unit names ohm, watt, ampere, kilogram, meter, coulomb, and second build up products and quotients. Names of physical quantities are used in equation 4. In equation 5 the velocity of light is expressed by the product of the number 2.99792×10^8 and the unit symbol m per sec. In the series of equations 6, products of products of numbers and names of units are used. This last example is taken from an article published in 1888 by Lodge.[2]

Indeed, multiplying a numerical value by a unit is of long usage. As is well known, it was familiar to Maxwell. The first paragraph of the first article of his famous treatise reads as follows:[3] "Every expression of a Quantity consists of two factors or components. One of these is the name of a certain known quantity of the same kind as the quantity to be expressed, which is taken as a standard of reference. The other component is the number of times the standard is to be taken in order to make up the required quantity. The standard quantity is technically called the Unit, and the number is called the Numerical Value of the quantity."

But in the second paragraph of the second article Maxwell writes, "The formulae at which we arrive must be such that a person of any nation, by substituting for the different symbols the numerical values of the quantities as measured by his own national units, would arrive at a true result." In accordance with this statement, Maxwell later on used only measure equa-

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tions, not quantity equations. But, with a coherent system of units, the forms of the measure equations and of the quantity equations are exactly the same because the units cancel out.

Lodge,[2] in 1888, published an article entitled "The Multiplication and Division of Concrete Quantities," at the end of which he states that the equations between numerical values alone "are only special deductions from the higher kind of equation: from the true fundamental equations which exist among the quantities themselves."

In 1922, Wallot[4] started a renaissance of these earlier ideas involving equations between quantities, based on the statement: Quantity = numerical value × unit. And he was very successful. Quantity calculus is now firmly established in central Europe. Wallot's book[5] gives a good survey of the working power of quantity calculus and of many problems in connection with it. But epistemologic questions are not discussed. Many quotations refer to the rich literature on the subject.

Two questions remained unanswered for a long time: Is the combination of a numerical value and a unit really a product? And are mathematical operations really feasible with physical quantities themselves? Indeed, the concepts of product and quotient were defined in algebra first for numbers only. Then they were expanded to complex numbers, in accordance with the principle of the permanence of mathematical laws. Vectors, tensors, matrices followed. In the concept of a "field," which is familiar in abstract or higher algebra, two sorts of mathematical operations, called "compositions," are defined: one called addition, the other multiplication. The inverse operations, that is, subtraction and division also exist. For a "group," which is another subject dealt with in abstract algebra, only one composition and its inverse exist. They may be called multiplication and division. Such items are treated in books dealing with abstract algebra, for instance, by Jacobson[6] and Stoll.[7] The reason for applying these names for operations performed with other "elements" than numbers is that the laws governing such operations are the same as the laws ruling addition and multiplication of numbers. An illustrative example of a group is the group of permutations described in the Appendix. Permutations can be composed and this composition may be called multiplication.

In 1943, Landolt[8] applied the concept of group to the theory of physical quantities. San Juan worked on the same subject and published a book[9] in 1947. Dealing with the structure of the system of physical concepts, Fleischmann[10] applied groups in 1951. Page, in 1952, stated[11] that elements having dimensionality needed only group properties.

A first result is that one is on firm ground when speaking of the product of a numerical value and a unit as forming a physical quantity. As is generally done, we shall say "quantity" only, instead of "physical quantity."

A second result is that it is correct to speak of products and quotients of quantities. One can form products and quotients of quantities as ordinary algebra does with numbers. For "quantities of the same kind" also addition and subtraction are allowed. Applying these mathematical operations to quantities is called "quantity calculus." Generally, the geometric character of quantities, that is, the fact that quantities may be scalars, vectors, or tensors, is not retained in quantity calculus and will not be done in this text.

Based on the first result, one may express a quantity X by the equation

$$X = \{X\}_a [X]_a \tag{7}$$

where $\{X\}_a$ is the "numerical value" or the "measure" and $[X]_a$ is the "unit," the special system of units referred to being identified by the subscript $_a$.

If there are different units for the same quantity X, one belonging to the unit system a, the other to unit system b, one has from equation 7

$$X = \{X\}_a [X]_a = \{X\}_b [X]_b$$

Hence,

$$\frac{\{X\}_a}{\{X\}_b} = \frac{[X]_b}{[X]_a} \tag{8}$$

It is well known that when units are changed, numerical values change inversely. Or, in more scientific language, numerical values transform "contragredient" to units.

For example, in the International System of Units (SI) as adopted in 1956 by the International Committee of Weights and Measures and identified by the subscript $_{SI}$, the unit of force F is the newton N; in the cgs system, identified by the subscript $_{cgs}$, the dyne is the unit of force. Therefore one has

$$[F]_{SI} = \text{N} \qquad \text{and} \qquad [F]_{cgs} = \text{dyne} \tag{9}$$

From equations 8 and 9 one may conclude that

$$\{F\}_{cgs} = \frac{[F]_{SI}}{[F]_{cgs}} \{F\}_{SI} = \frac{\text{N}}{\text{dyne}} \{F\}_{SI}$$

Because the "unit equation"

$$1 \text{ dyne} = 10^{-5} \text{ N} \tag{10}$$

holds, equation 11 results:

$$\{F\}_{cgs} = 10^5 \{F\}_{SI} \tag{11}$$

A third result of applying group theory to quantities is that every "derived quantity" X might be expressed correctly in the following manner:

$$X = \{X\}_a [A_1]_a^{x_1} [A_2]_a^{x_2} \dots [A_n]_a^{x_n} \tag{12}$$

Here X is an "element" of the group of quantities, the $[A_1]_a$, $[A_2]_a$, $\dots [A_n]_a$ are (besides the numbers $\{X\}_a$) the n "generating elements" of the group; they are called "basic units" and are particular values of the "basic quantities"

$$\begin{aligned} A_1 &= \{A_1\}_a [A_1]_a \\ A_2 &= \{A_2\}_a [A_2]_a \\ &\vdots \quad\quad \vdots \\ A_n &= \{A_n\}_a [A_n]_a \end{aligned} \tag{13}$$

The exponents $x_1, x_2, \ldots, x_n$ are pure numbers. A system of units having n basic units is called an "n-dimensional system of units." The unit

$$[X]_a = [A_1]_a^{x_1}[A_2]_a^{x_2} \ldots [A_n]_a^{x_n} \quad \textbf{(14)}$$

is called a "derived unit."

As in ordinary algebra,

$$1X = X, 0X = 0 \quad \textbf{(15a and b)}$$

$$X^m \times X^n = X^{m+n} \quad \textbf{(16)}$$

$$X^0 = 1, \quad [A]_a^0 = 1 \quad \textbf{(17a and b)}$$

$$X \times Y = Y \times X, (X \times Y) \times Z = X \times (Y \times Z) \quad \textbf{(18a and b)}$$

If, besides the quantity X given in equation 12, there exists also a quantity

$$Y = \{Y\}_a [A_1]_a^{y_1} [A_2]_a^{y_2} \ldots [A_n]_a^{y_n} \quad \textbf{(19)}$$

new quantities Z and W may be formed; they are defined by

$$Z = XY \quad \textbf{(20)}$$

and

$$W = X/Y \quad \textbf{(21)}$$

In introducing equations 12 and 19, the numerical values and units of Z and W are found to result from the numerical values and units of X and Y.

ACTUAL PHYSICAL PHENOMENA AND SYSTEMS VS. QUANTITIES

A DISTINCTION MUST BE MADE between the actual physical phenomena and systems on one side and the quantities on the other side. The physical phenomena and systems are "the real thing"; their models with respect to the measurable properties are the quantities. Thus, quantities are used in equations while physical phenomena and systems may not be.

An analogous difference exists between standards and units; standards are special cases of physical phenomena and systems, while units are special cases of quantities. Indeed, units are quantities which have by definition a numerical value of exactly 1 for a determined system of units, and standards are embodiments of units and therefore material objects. In spite of the difference in signification the name of a unit and the corresponding standard are generally the same; for instance, "meter" is the name of the unit in terms of which the unit "U.S. yard" is defined by equation 1 as well as the name of the standard bar preserved in the International Bureau of Weights and Measures at Sévres, near Paris.

A rather subtle distinction must be made between two sorts of units and quantities, one called "concrete," the other "abstract." In most cases this existing difference is of no practical importance; also it is not evident, and may pass unnoticed. But in a few cases, as in rationalization, the difference becomes decisive.

A simple example may explain the situation: The unit of area is defined as the area of a square whose side length is unit of length, and the unit of volume is defined as the volume of a cube with the edge length unit of length. Thus, for the international system of units (SI), where the meter is the unit length

$$[A_{\text{square}}]_{\text{SI}} = \text{m}^2, \quad [V_{\text{cube}}]_{\text{SI}} = \text{m}^3 \quad \textbf{(22)}$$

These are unit equations. For the area of a square and the volume of a cube the following quantity equations hold:

$$A_{\text{square}} = a^2, \quad V_{\text{cube}} = a^3 \quad \textbf{(23)}$$

where a is the length of side or edge. For the area of a circle and the volume of a sphere with radius r:

$$A_{\text{circle}} = \pi r^2, \quad V_{\text{sphere}} = \frac{4}{3\pi} r^3 \quad \textbf{(24)}$$

The Babylonians had already used the square and the cube for defining units of area and volume. But let us assume as a working hypothesis that they had defined the unit of area to be the area of a circle and the unit of volume to be the volume of a sphere, both generated by rotation of a line of unit length about one of its extremities. If we should use these definitions, our unit equations would be

$$[A'_{\text{circle}}]_n = \text{m}^2, \quad [V'_{\text{sphere}}]_n = \text{m}^3 \quad \textbf{(25)}$$

In these unit equations, the system of the assumed Babylonian definitions is identified by the subscript n, and to avoid contradiction a prime is added to A and V. Another possibility would be to write $(\text{m}^2)_n$ and $(\text{m}^3)_n$.

The consequence of the assumed Babylonian definitions would be the following quantity equations for area of circle and square and volume of sphere and cube:

$$A'_{\text{circle}} = r^2, \quad V'_{\text{sphere}} = r^3 \quad \textbf{(26)}$$

$$A'_{\text{square}} = \frac{1}{\pi} a^2, \quad V'_{\text{cube}} = \frac{3}{4\pi} a^3 \quad \textbf{(27)}$$

In addition to the assumed Babylonian definitions (equation 25), which may be called "nonrationalized," the usual SI definitions (equation 22), which may be called "rationalized," exist; therefore besides quantity equations 26 and 27, equations 23 and 24 also hold.

Now, the difference between concrete and abstract units becomes evident as follows: The concrete units of area which are given by a square of side length 1 m in the SI system and by a circle with radius 1 m in the n system (according to the assumed Babylonian definitions) are connected by the unit equation

$$[A_{\text{square}}]_{\text{SI}} = \frac{1}{\pi} [A'_{\text{circle}}]_n \quad \textbf{(28a)}$$

Similarly,

$$[V_{\text{cube}}]_{\text{SI}} = \frac{3}{4\pi} [V'_{\text{sphere}}]_n \quad \textbf{(28b)}$$

Instead of these unit equations one could also write

$$1(\text{m}^2)_{\text{SI}} = \frac{1}{\pi} (\text{m}^2)_n, \quad 1(\text{m}^3)_{\text{SI}} = \frac{3}{4\pi} (\text{m}^3)_n \quad \textbf{(29)}$$

The abstract units m^2 and m^3, being powers of m, cannot by definition of powers have two different val-

ues for different systems of units. Therefore unit equations 28 and 29 are not possible for abstract units. To avoid contradictions, one must use two pairs of quantities to describe the actual physical phenomena and systems, one written with prime, one without. But this duplicity does not exist in the actual physical phenomena of area and volume.

The origin of these disturbing complications lies in the fact that the usual SI definitions and the assumed Babylonian definitions of units of area and volume assign two different physical significations to m^2 and also to m^3. We are happy that this duplicity does not exist and was only assumed to illustrate the consequences of having two different definitions.

Concrete quantities and units, being immediate mental representations of actual physical phenomena and systems, exist only when the latter exist. Abstract units, however, are mathematical compositions and therefore exist by themselves, as do abstract quantities as multiples or parts of abstract units. For instance, the abstract unit m^7 exists as does the abstract quantity 205 m^7, but no corresponding actual physical phenomenon and system are known; therefore the corresponding concrete unit and quantity do not exist. Another example is negative masses; these exist only as abstract quantities.

The relation between concrete and abstract quantities and units is very intimate. Their differences become evident in special cases only. Therefore, different names would be not only unnecessary but disturbing. It is sufficient to speak in both cases of quantities and units and to indicate the difference, if necessary, by using the adjectives "concrete" and "abstract."

One may say that the set of concrete quantities and units can be "mapped" on the set of abstract quantities and units. The inverse is not always possible. Also, concrete quantities and units differ from their abstract correlatives by their minor degrees of abstraction.

Koenig[12] was first to state that two different concepts of quantities and units, that is, concrete and abstract ones, are used. Quantity calculus, as previously described, deals with abstract quantities and units.

THE CASE FOR RATIONALIZATION

RATIONALIZING THE EQUATIONS of the electromagnetic field means abandoning several equations and replacing them by some others, with the aim of making the factor 4π disappear where no spherical arrangements are dealt with. For instance, for a sphere and for a plane capacitor the two nonrationalized equations

$$C_{\text{sphere}} = r\,\epsilon_n, \quad C_{\text{plane}} = \frac{A}{4\pi\,\delta}\,\epsilon_n \tag{30}$$

are replaced by the rationalized equation

$$C_{\text{sphere}} = 4\pi\,r\epsilon_r, \quad C_{\text{plane}} = \frac{A}{\delta}\,\epsilon_r \tag{31}$$

where A is the area, δ the distance between plates, r the radius of the sphere, and ε the permittivity.

The consequences for magnetic field strength H are the following: the nonrationalized defining equation is based on a winding, conducting current I and is seen from the point, in which H_n exists, under the solid angle ω. The defining equation is

$$H_n = -I\ \text{grad}\ \omega \tag{32}$$

(The minus sign is of no importance for units)

The gradient of a solid angle being a reciprocal length, the unit of grad ω is m^{-1} in the International System of Units; therefore

$$[\text{grad}\ \omega]_{SI} = m^{-1} \tag{33}$$

Further, one has

$$[I]_{SI} = A \tag{34}$$

Hence

$$[H_n]_{SI} = A/m \tag{35}$$

Use of equation 32 for evaluating the magnetic field strength in an infinitely long solenoid yields

$$H_n = 4\pi\,\frac{N}{l}\,I \tag{36}$$

where l is the length occupied by N turns conducting current I. The rationalized equation for the same case is

$$H_r = \frac{N}{l}\,I \tag{37}$$

The unit of H_r with

$$[N]_{SI} = 1 \tag{38}$$

and

$$[l]_{SI} = m \tag{39}$$

becomes

$$[H_r]_{SI} = A/m \tag{40}$$

The abstract unit A/m based on the solid angle and referred to in equation 35 and based on the solenoid referred to in equation 40 does not correspond to the same actual physical phenomenon of magnetic field strength, this phenomenon being in the latter case 4π times as strong as in the former. For concrete units, therefore,

$$(A/m)_r = 4\pi(A/m)_n \tag{41}$$

But this equation is not possible for abstract units, the quotient A/m having only one meaning in quantity calculus. To avoid contradictions in dealing with abstract quantities and units, one must distinguish between the abstract quantities H_n and H_r. They are connected by

$$H_n = 4\pi\,H_r \tag{42}$$

which follows from equations 36 and 37.

Other quantities are also affected by rationalization, such as permeability, electric flux, electric flux density, and permittivity.

The origin of all these complications lies in the fact that in defining some quantities and units in two different ways, in both a nonrationalized and a rationalized manner, one gives two different physical meanings

to one abstract quantity or unit. Quantity calculus cannot accept the coexistence of two different meanings for the set of elements dealt with, because its compositions are not bivalent. The case of one element of quantity calculus corresponding to two actual physical phenomena is like interpreting the abstract unit m^2 by a square with side length of 1 meter or by a circle with a radius of 1 meter, as previously described. But while this twofold interpretation of the second power of the unit of length is only an unrealistic hypothesis, the twofold definition of the unit of magnetic field strength based on units of current and length was introduced in electromagnetic theory and has been adopted by the International Electrotechnical Commission[13] (IEC) and other standardizing bodies.

Silsbee[1] spoke of an "unhappy moment" in which, through a question about the interpretation of rationalization, a very long discussion took place. That moment should be called a happy one because the question asked by Prof. Jan de Boer prevented the IEC from taking action without thinking of the consequences. The question provided the opportunity to clear up the matter and to give attention to the fact that rationalizing means changing defining equations, a process demanding care. All difficulties and discussions would have been avoided if one had introduced new names and symbols for quantities newly defined by the rationalized defining equations. But this had not been done when, after a few years, rationalization originated; it was no longer possible when the International Electrotechnical Commission adopted the rationalized form of the equations of electromagnetism. The International Union of Pure and Applied Physics, when adopting rationalization, made an attempt and introduced different symbols, for instance $_{n}H$ and $_{r}H$ for nonrationalized and rationalized magnetic field strength.[14]

CONCLUSIONS

EVERY ACTUAL PHYSICAL PHENOMENON may be represented in equations either by concrete quantities and units or by abstract quantities and units. Each is a mathematical model of a different grade of abstraction, and between them exist close relationships which are generally nonambiguous. Some complications exist in the case of rationalization, where earlier, nonrationalized definitions are replaced by later, rationalized ones. Changing over from the nonrationalized to the rationalized form of the field equations means for magnetic field strength and some other quantities such as permeability, electric flux, electric flux density, and permittivity that concrete units change while concrete quantities remain invariable as do the represented phenomena; however, in quantity calculus abstract units are invariable in themselves, but changing over makes abstract quantities change. Different names for the two sorts of quantities and units are not necessary; it is sufficient to use the adjectives "concrete" and "abstract" if necessary.

In the daily use of electrical engineering the existing complications appear only when one transposes values given in a nonrationalized system of units (and definitions) to a rationalized one, that is, from one of the cgs systems to the SI. Such transpositions can be done safely in using conversion factors for the numerical values.

Appendix: Examples of a Group

Permutations give well-known examples for groups. For instance, a set of five distinct things called a, b, c, d, e may be given. A permutation A of this set may replace a by b, b by c, c by d, d by e, and e by a. This permutation is expressed by

$$A = \begin{pmatrix} a & b & c & d & e \\ b & c & d & e & a \end{pmatrix} \tag{1}$$

The place of the things in the array is of no importance; thus

$$A = \begin{pmatrix} b & e & c & a & d \\ c & a & d & b & e \end{pmatrix} \tag{2}$$

is exactly the same A as given in equation 1.

Another example is

$$B = \begin{pmatrix} a & b & c & d & e \\ c & d & b & a & e \end{pmatrix} \tag{3}$$

Applying first permutation A, then permutation B is called a product; it is written

$$C = A\,B \tag{4}$$

The result, being found by replacing, first, a by b, and then b by d, etc., becomes

$$C = \begin{pmatrix} a & b & c & d & e \\ d & b & a & e & c \end{pmatrix} \tag{5}$$

Analogically,

$$B\,A = \begin{pmatrix} a & b & c & d & e \\ d & e & c & b & a \end{pmatrix} \tag{6}$$

from which it is clear that multiplication is not commutative.

If A^{-1} is called the inverse of A, the changes produced by A are reset. From this it follows, with the use of equation 1, that

$$A^{-1} = \begin{pmatrix} a & b & c & d & e \\ e & a & b & c & d \end{pmatrix} \tag{7}$$

Permutation E is defined as the unit permutation. It changes nothing:

$$E = \begin{pmatrix} a & b & c & d & e \\ a & b & c & d & e \end{pmatrix} \tag{8}$$

The definition of A^{-1} yields

$$A\,A^{-1} = E \tag{9}$$

It is immediately clear that

$$A\,E = E\,A = A \tag{10}$$

This means that E plays the same role as the number 1 in ordinary algebraic multiplication.

The aim of this example is to illustrate that the concepts of multiplication, etc., may be defined not only for numbers but also for quite a few other things.

REFERENCES

1. Does Rationalization Change Units? F. B. Silsbee. *Electrical Engineering*, vol. 76, Apr. 1957, pp. 296-99.

2. The Multiplication and Division of Concrete Quantities, A. Lodge. *Nature*, London, England, vol. 38, July 19, 1888, pp. 281-83.

3. A Treatise on Electricity and Magnetism (book), J. C. Maxwell. Clarendon Press, Oxford, England, second edition, 1881.

4. Die physikalischen und technischen Einheiten (The Physical and Technical Units), J. Wallot. *Elektrotechnische Zeitschrift*, Wuppertal-Elberfeld, Germany. Vol. 43, Nov. 2, 1922, pp. 1329-33, Nov. 16, 1922, pp. 1381-86.

5. Groessengleichungen, Einheiten und Dimensionen (Quantity Equations, Units and Dimensions) (book), Julius Wallot. Johann Ambrosius Barth Verlag, Leipzig, Germany, 1953, second edition, 1957.

6. Lectures in Abstract Algebra (book), N. Jacobson. D. Van Nostrand Company, Inc., Princeton, N. J., vol. 1, 1951.

7. Linear Algebra and Matrix Theory (book), R. R. Stoll. McGraw-Hill Book Company, Inc., New York, N. Y., 1952.

8. Groesse, Masszahl und Einheit (Quantity, Measure and Unit) (book), M. Landolt. Rascher Verlag. Zurich, Switzerland, 1943, second edition, 1952. French translation by Emile Thomas: Grandeur, Mesure et Unite. Editions Dunod, Paris, France, 1947.

9. Teoria de las Magnitudas Fisicas y sus Fundamentos Algebraicos (Theory of Physical Quantities and its Algebraic Foundations) (book), R. San Juan Llosá. C. Bermejo, Impressor, Madrid, Spain, 1947.

10. Die Struktur des physikalischen Begriffssystems. (The Structure of the System of Physical Concepts), R. Fleischmann. *Zeitschrift für Physik*, Berlin-Charlottenburg, Germany, vol. 129, Apr. 2, 1951, pp. 377-400.

11. Units and Dimensions in Physics, C. H. Page. *American Journal of Physics*, New York, N. Y., vol. 20, Jan. 1952, pp. 1-4.

12. Ueber die Mehrdeutigkeit des Groessenbegriffs (about the Ambiguity of the Concept of Quantity), H. Koenig. *Bulletin*, Schweizerischer Elektrotechnischer Verein, Zurich, Switzerland, vol. 41, Aug. 19, 1950, pp. 625-29.

13. Recommendations of IEC Technical Committee no. 24 on Electric and Magnetic Magnitudes and Units, J. J. Smith. AIEE *Tranactions*, pt. I (*Communications and Electronics*), vol. 74, Mar. 1955, pp. 37-39.

14. Symbols and Units (book). International Union of Pure and Applied Physics—S.U.N. Commission. Document U.I.P. 6, 1955, p. 16.

Motivation through Challenge

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FELLOW AIEE

P. R. CLEMENT

Strong intellectual challenge is the most effective means of student motivation. Electrical engineering education during the past few years has been developing in precisely this direction. A 5-year experimental curriculum that helps stimulate the student's will to learn through this kind of challenge is described.

EVERY teacher is well aware of the importance of motivation in the performance of his students. It is a matter of common observation that a student of superior ability who loses his desire to learn quickly becomes an academic liability. Achievement seems to be something like the product of natural ability times motivation, integrated over the period of learning. Although the source of motivation is sometimes beyond the instructor's control, on the average it is the teacher himself who must take the responsibility for generating in his students not only the desire to learn but the will to do the work of learning.

Two outstanding characteristics of the young man are his willingness to accept a challenge and his desire to test himself on difficult tasks. In fact, if challenges do not naturally arise, he is likely to manufacture them. He has the belief, often justified, that he has the ability to accomplish great things in the future. Furthermore, he has the important advantage over his elders of having the time to prepare himself for distant goals.

Most teachers will agree that another outstanding characteristic of the college student is the basic desire to learn and to fit his knowledge into a coherent whole. The student of college age can assimilate knowledge and master ideas at the greatest rate of his life. His intelligence is fully developed, his mind is uncluttered, and his approach to new ideas is fresh and uninhibited.

People, as is well known, are creatures of habit. Good habits of intellectual discipline, like muscles, are developed more easily in young people than in old, and this development is obviously one of the important objectives in a college education. Intellectual skill, fully as much as physical skill, is acquired only through practice and exercise.

So far we have called attention to, and tried to formulate precisely, only what every teacher knows but that all of us are sometimes inclined to forget: that young people require challenges, that they are the most competent learners, and that it is an important function of the teacher to provide the challenge. It is not likely that the teacher will neglect to enforce intellectual discipline, for this is his traditional job. But each of us, being of the older generation, is likely to discount the competence of youth and thereby fail to offer the stimulation and challenge that such competence deserves, and fail to require the full measure of intellectual discipline that the young person is capable of giving.

SOPHISTICATED IDEAS CAN BE GRASPED

THE DEVELOPMENT that have taken place in electrical engineering education over the past few years are in precisely the direction of greater challenge to the student, and it is the effect of these new programs and courses on the student that confirm the belief in challenge as a motivating factor. The general characteristics of the new programs have been an increased emphasis

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on the scientific aspects of electrical engineering and on the introduction of sophisticated ideas at an early stage and in reasonably rapid order. There are many who, from experience, will agree to the stimulation afforded to the student through his grasp of ideas that were formerly thought to be the province of the graduate student or, indeed, were not taught at all. The main problem is not the ability of the student to assimilate ideas; the problem is to formulate the ideas clearly and correctly without overshooting the mathematical preparation of the student. If all high schools taught good courses in calculus, the flow of ideas could be ever so much faster in the first 2 years of college.

An introductory course in electrical engineering must wait for the student to get reasonably well along in the calculus and so is generally given, or started, in the sophomore year. There are at least two schools of thought concerning the first course: one holds that circuit theory is the logical starting point, both because of its importance in the field of electrical engineering and because its mathematical requirements and its order of difficulty seem appropriate to the student at this point. Another school of thought believes that the basic concepts of electricity and magnetism form a more appropriate starting point because they are more fundamental than circuit theory; they are introduced in a physics course often given in the freshman year and can appropriately be carried forward immediately in the sophomore year; and the ideas, if formulated properly, are appropriate to this level of learning. The physical ideas of circuit theory are then established preparatory to the exploration of the mathematical aspects of networks.

FIVE-YEAR EXPERIMENT DESCRIBED

EACH OF THE FOREGOING INTRODUCTIONS—the physical aspects of field and circuit theory, and the mathematical aspects of networks analysis—can provide challenge for the student. The authors believe in starting with the field approach, and will conclude this paper with a brief description of a 5-year experiment made from this point of view.

As is true in many schools, our freshmen take elementary differential and integral calculus with analytic geometry and general physics with emphasis near the end on electricity and magnetism. By the sophomore year the student knows what a derivative and an integral are, and he can differentiate and integrate simple functions, but his mathematical background has not reached the point where he can make use of partial differentiation and the other mathematical apparatus often associated with a sophisticated approach to electromagnetic theory. We feel, however, that this can be a blessing in disguise, for the ideas of electromagnetic theory are physical, and too much mathematics at the beginning can obscure the physical concepts. Our aim is to present the physical ideas correctly and in such a form that the student will not need to unlearn them later. In such a presentation the student can see that mathematics of a more advanced kind would permit him to manipulate the physical ideas more adroitly and to solve problems of greater complexity; thus it motivates him in his study of mathematics. We use the ideas of differential and integral calculus freely and introduce the multiplication of vectors, but go no further than this into vector analysis. We are therefore limited to the integral formulation of Maxwell's equations and to examples and problems which have a high degree of spacial symmetry. Fortunately, many interesting problems can be solved within this limitation. Since we are using the student's mathematics soon after he learns it, we must keep informed about what the mathematics department is doing, to avoid the mistake of assigning problems that require, for example, previously unexplained techniques of integration.

The material on electricity and magnetism occupies about half a semester and includes as examples and problems many applications in engineering. Immediately thereafter the basic principles are applied to two areas: to the conversion of energy, with emphasis on electromechanical transducers, and to the theory of lumped circuits, with particular attention to the relation between the physical concepts and their mathematical formulation. Thus, the treatment proceeds from field ideas to circuits and physical apparatus, and to their mathematical models. With the circuit relations formulated, attention turns to the analysis of networks, starting with network topology and extending through zero-pole ideas. The material of the 1-year introductory course stops just short of the Laplace transform.

In the accompanying weekly laboratory periods, experiments are performed only on alternate weeks in the first semester to allow the class work to get ahead, and are held somewhat more often during the second semester. The remaining laboratory periods are used for problem solving, particularly for problems which are more difficult mathematically or in which the student requires some guidance in the exercise of judgment, as in making a design. The laboratory proper stays as nearly as possible in step with the theory taught in class. In both problems and laboratory, the objective is to show the practical use of the theory and the limitations of the models which one uses to analyze physical situations. In one experiment the student uses a simplified oscilloscope to measure the forces exerted on a stream of electrons by electric and magnetic fields. He also learns something of using the instrument, how the focusing and intensity controls interact, and so on. Something of the techniques of measurement are taught, together with their pitfalls: the d'Arsonval instrument as ammeter, voltmeter, and ohmmeter, bridges, pen recorder, oscilloscope, the d'Arsonval instrument with a rectifier, and so on.

When the student reaches circuit theory he uses sinewave and squarewave generators to observe the transient and steady-state behavior of networks. Anomalies, predicted by field theory but not by the lumped model, are observed. In one of the most popular experiments, the student is required to deduce the configuration of elements in one of a set of 2-terminal black boxes, using

any measuring equipment that he thinks will help him toward the answer. There are two experiments on d-c machinery, and they are surprisingly popular, perhaps because the students enjoy their mastery over a powerful machine but do not have enough time with it to become bored. Work on transformers, with emphasis on frequency response, and some basic experiments on polyphase networks, end the year's work.

Along with the introductory course in electrical engineering, the sophomore student finishes his sequence in the elementary calculus and takes a semester of differential equations. The second semester contains a physics course in electromagnetic theory that uses vector calculus and carries further into the mathematical aspects of the subject.

At this point the student is far enough along with ideas and techniques so that his succeeding courses can proceed rapidly. As a junior, he has a semester of engineering analysis, a semester of energy conversion and control, and a year of communication systems and electronic circuits. The junior course in communication presents the elementary system aspects of the subject before the circuitry in the belief that the question of "why" should be answered before "how." First presented is simplified communication theory and signal theory. After the student has seen something of what he is trying to do, vacuum-tube and transistor circuits are introduced as convenient means of accomplishing the desired results. The classroom treatment continues to discuss theory and the models of physical apparatus, while the laboratory shows the practical features, the limitations of the models, and the techniques of measurement, and emphasizes the use of judgment in design. Here the student learns by hard experience the effects of the wrong decimal point, the ground loop, and leads that are too long. To save time, pegboards are generally used to hold individually mounted components, and leads with friction connectors are used for the wiring. But sometimes the student must deal with manufactured gear and must read its diagrams and locate its parts, and sometimes he must make a real breadboard and solder the joints well.

Together with the junior courses in electrical engineering the student takes a mathematics course in functions of a complex variable, and a semester of modern physics. He often elects additional physics courses in atomic theory and electromagnetic theory, and many elect to take analytical mechanics in the physics department rather than in mechanical engineering. Thermodynamics also may be taken in either department.

This is all basic preparation for the senior year, where the student takes a more advanced course in electronic circuits and chooses among physical electronics, feedback control, microwave devices and applications, signal and communication theory, switching theory and logical design, digital computation, further courses in mathematics and physics, and independent work.

The program is a challenging one, no less in the sophomore year than later. There were some who originally feared that an introductory course of such an ambitious nature would lose students from the department, but they underestimated the motivating effect of a challenge. Students, instead, transferred into the department. A common statement was to the effect, "I hear that your department is difficult but that your students learn a lot. I want to join up with you." We are pleased at the increasing number of students from physics, mathematics, chemistry, and even economics who elect our courses. On the basis of all evidence, the experiment has been successful.

Locomotives for Brazil

A record-breaking $23.5 million order for 180 locomotives for eight of Brazil's railroads will be filled by the General Electric Company's Locomotive and Car Equipment Department, Erie, Pa. The order is the largest ever placed by a national railroad administration, according to GE sources.

The majority (173 units) of the locomotives will be diesel-electrics of the universal type suitable for any type of railroad service. The remaining seven will be electric units for operation from overhead power lines. Highly standardized design of the universal-type diesel-electrics makes it possible to manufacture them on an assembly-line basis.

Maintenance and operating personnel from several of the Brazilian Government's rail lines will receive special training at General Electric's Erie locomotive plant.

View of two GE U8B units

The diesel-electrics are *U5B* and *U8B* models developing 600 and 900 gross hp respectively. The all-electric units develop 3,000 rail-hp each.

Breakdown Strength of Nitrogen at High Temperatures

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IN A-C circuit-interrupting devices, the post-arc period immediately after current zero is of paramount importance. This period is characterized by the rapid cooling and deionization of the hot gases between the contacts, which build up the dielectric strength of the gap. Simultaneously, however, the circuit transients resulting from the interruption of the current impose a rapidly increasing voltage across the contact gap. This so-called recovery voltage may break down the gap and re-establish the arc.

Some authors have speculated that after current zero,

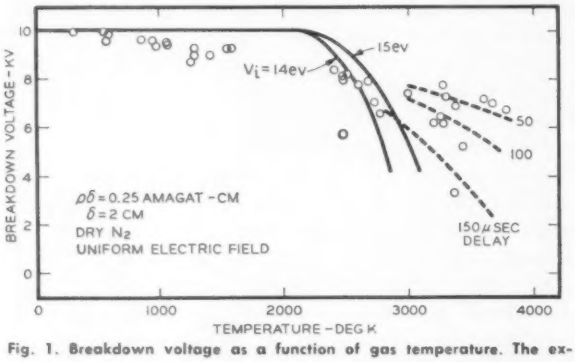


Fig. 1. Breakdown voltage as a function of gas temperature. The experimental points correspond to various delay times for application of the pulse; the dashed lines are obtained by interpolation for the indicated times. The solid curves are from an analysis involving no fitting parameters. The symbols: $\delta = 2$ cm; $\varrho = \frac{1}{8}$ amagat, where 1 amagat is the density of the particular gas at standard temperature and pressure.

if the electrical conductivity is very low, the breakdown is of an electronic nature. Others have postulated a thermal breakdown mechanism for the case where the conductivity is reasonably high. To test these ideas, one needs considerable experimental information on the influence of gas temperature, pressure, velocity, and degree of ionization on the breakdown strength of a gas. Unfortunately, such information has not been generally available in the literature; breakdown in gases has been studied only for temperatures between 1,000 and 1,400 K (degrees Kelvin). For the purpose of circuit interruption studies, data at much higher temperatures are required.

In the present work, a new technique for studying the electric breakdown of high-temperature gases is developed; the novel feature is the use of a shock tube to produce the desired high-temperature gas conditions. A shock wave is used to heat and accelerate a gas between a pair of electrodes, and after the shock front has passed, a voltage pulse is applied to the heated gas and its breadown strength is measured. Throughout these experiments, the electrode spacing and gas density behind the shock have been maintained constant, as the shock strength has been varied.

Paschen's similarity law states that the breakdown potential of a given gas in a uniform electric field is a function of the product of the electrode spacing and the gas density. Therefore, on this basis, the breakdown potential measured at different shock strengths would be expected to remain constant, any observed change being indicative of an effect of gas velocity or of temperature (i.e., other than the density dependence on temperature). Earlier measurements made by others under static conditions have shown no significant deviations from Paschen's law in nitrogen and air up to temperatures of 1,100 and 1,400 K respectively.

In our experiments, temperatures in excess of 4,000 K, and gas velocities as high as 2,500 meters per second have been attained. Marked deviations from similarity behavior have been observed at temperatures above 1,500 K, and by 4,000 K the breakdown voltage has fallen to about half of its room temperature value; see Fig. 1. A decrease in breakdown voltage with increasing temperature occurs because at these high temperatures the gas becomes quite thermally ionized.

At a given temperature the breakdown potential decreases with increasing time after the passage of the shock front, which indicates that the degree of ionization is changing with time. The existence of this relaxation process has been substantiated by auxiliary measurements of low field resistivity, and luminosity of the gas. These observations indicate that the relaxation time of nitrogen is several hundred microseconds, even at 4,000 K; because of this, all of our measurements were made under nonequilibrim conditions.

Even so, calculations based upon equilibrium considerations indicate a reasonable agreement between the observed breakdown voltages and what one would expect theoretically, as Fig. 1 shows. Moreover, it may be remarked that although the attainment of thermal equilibrium is a desirable condition for fundamental work, our nonequilibrium study is probably more representative of the conditions met in practice, in the operation of air-blast switchgear, for example.

At the highest temperatures (4,000 K) remarkably high prebreakdown currents were observed in the shock tube. There may be a resemblance between these currents, and the post-arc currents which have been observed in circuit breakers. If this is so, then the shock tube technique provides a useful method for investigating the nature of post-arc phenomena.

Digest of paper 61-136, "An Investigation of the Breakdown Strength of Nitrogen at High Temperature Using a Shock Tube," recommended by the AIEE Switchgear Committee and approved by the AIEE Technical Operations Department or presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 29-Feb. 3, 1961. Published in AIEE *Power Apparatus and Systems*, June 1961, pp. 333-44.

A. H. Sharbaugh, P. K. Watson, and D. R. White are with General Electric Company, Schenectady, N. Y.; T. H. Lee and Allan Greenwood are with General Electric Company, Philadelphia, Pa.

Analog Field Plotter—Description and Use

C. W. PARK
MEMBER AIEE

J. J. BARALE

The conductive-sheet analog field plotter is a versatile instrument for the study of various types of 2-dimensional field patterns. By means of a field plotter, one can frequently optimize the design of a device without having to fabricate several experimental models. Thus, a substantial savings in both time and money can be achieved.

THE conductive-sheet analog plotter has a number of advantages over other types of analog devices, such as the electrolytic trough. The latter is difficult to set up, the liquid is spillable, and one cannot obtain a directly recorded plot. By contrast, the conductive-sheet plotter is clean and convenient, and permits a direct visual plot of either equipotential or flux lines. Further, one can easily represent different dielectric materials, as discussed later on.

At the Lawrence Radiation Laboratory the main use of the conductive-sheet analog field plotter is in connection with the study of electric current fields, electrostatic fields, and magnetostatic fields. However, with appropriate techniques one can also utilize the field plotter to map fluid flow patterns and velocity gradients, heat flow patterns and temperature distributions, air flow patterns, etc.

DESCRIPTION OF THE ANALOG FIELD PLOTTER

AN ANALOG FIELD PLOTTER consists of a plotting board, a search stylus, and a sensing instrument (Fig. 1). The plotting board is a piece of ¾-inch-thick plywood covered with a sheet of Western Union black conducting paper without coating. This paper has a resistivity of about 2,000 ohms per square. A cross section of the conducting portions of the device being studied is painted onto this paper with Du Pont no. 4817 silver paint, which has a resistivity of approximately 3 ohms per square.

The search stylus is a pencil-like brass rod. Except for the point, it is covered with an insulating sleeve. The point of the stylus has a radius of 0.005 inch. A sharper point might scratch the surfaces of the conducting paper and alter the local resistivity.

The sensing instrument consists of a power supply, a voltage divider, and a null detector housed in a compact case (Fig. 2). Fig. 3 is a circuit schematic. The power supply provides 6.3 volts a-c (60 cps) across the simulated electrodes painted on the conducting paper, setting up an electric-current field in the paper. Contact with the painted surfaces is made very simply. The leads from the power supply terminate in two small brass cylinders. These brass electrodes are merely set on the painted surfaces. The power supply also provides —9.5 volts d-c to the null detector.

The voltage divider is a 10-turn 500-ohm precision potentiometer connected in parallel with the simulated electrodes.

The null detector is connected in series between the swinger of the potentiometer and the search stylus. For a given potentiometer setting, the search stylus is moved over the paper to locate null points. These are indicated by a zero reading on the meter of the null detector. The signal from the search stylus is amplified by a transistor 60-cycle amplifier which is gain-stabilized by feedback. The amplifier has an adjustable gain, 10 or 100. The low gain is used for locating the approximate position of a null point; the high gain is then switched on to find its exact location. The output is read on a microammeter connected across a bridge rectifier. A small phase-shifted signal provides a non-null reading when the probe is lifted from the paper or is making poor contact. This feature prevents false readings.

USE OF THE ANALOG FIELD PLOTTER

FIG. 4 ILLUSTRATES a simple problem: how to use the analog plotter to map the electrostatic field pattern between two oppositely charged parallel wires. The rectangular borders shown in Figs. 4 and 5 are not intended to be the actual limits of the piece of con-

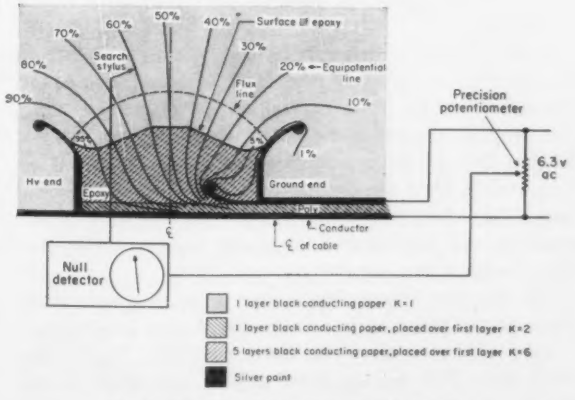


Fig. 1. Conductive-sheet analog field plotter

A special article recommended for publication by the AIEE Publications Department.

C. W. Park and J. J. Barale are with the Lawrence Radiation Laboratory, University of California, Berkeley, Calif.

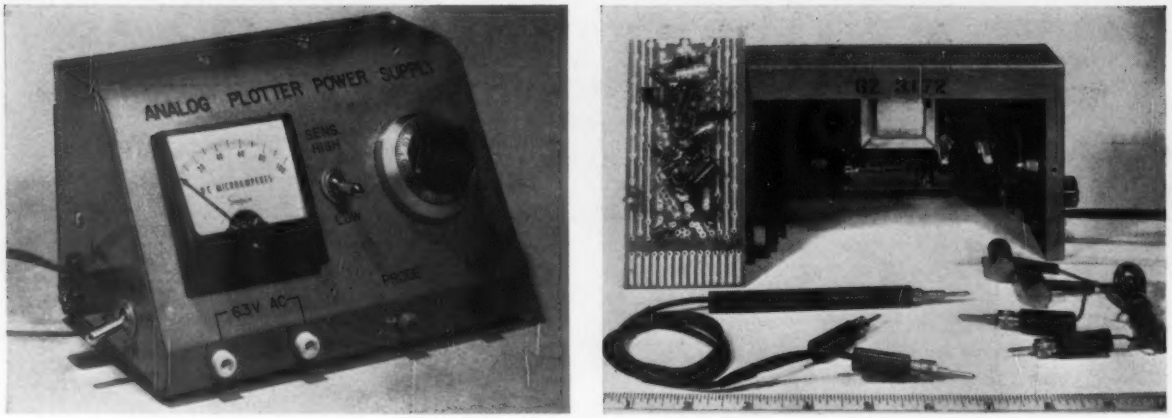


Fig. 2. Sensing device, front and rear views, containing the power supply, voltage divider, and null detector

ducting paper used. The actual size of the conducting sheet would be two to three times larger to simulate an infinite boundary.

Obtaining Equipotentials

a. Step 1. Paint the electrodes onto the black conducting paper. In this case the electrodes will be solid circles, corresponding to the cross sections of the parallel wires.

b. Step 2. Energize the electrodes in order to establish a current flow in the paper.

c. Step 3. Set the potentiometer to, say, 10% and then plot the null points. With a pencil, connect these to give an equipotential.

d. Step 4. Set the potentiometer at a different value, say, 20% and proceed as in Step 3. By repeating this process at 10% (or smaller) intervals, a family of equipotentials is obtained.

Obtaining Flux Lines. If one now wants the flux lines, he can draw them in freehand as a family of curves orthogonal to the equipotentials. In this simple example this would be the fastest method. However, where more complex geometries are involved, one may want to plot the flux lines directly. If so, an "inverse" method is used. This will now be described using the previous example:

a. Step 1. Cut out the original electrodes with a pair of scissors.

b. Step 2. Paint on new electrode strips as shown in Fig. 5. The margins of the new electrodes must be orthogonal to the lines of Fig. 4.

c. Step 3. Engergize the electrodes to set up electric current flow in the conducting paper.

d. Step 4. Plot the equipotentials as in the previous case. The family of curves thus obtained will be orthogonal to the first family, and will represent the flux lines between the parallel wires.

The second ("inverse" plot may be made on the same sheet as the first, so that a combined plot is obtained.

Typical Uses of the Field Plotter at LRL. Fig. 6 illustrates how this analog field plotter was used in designing the ion source and extractor for the heavy-ion linear accelerator at the Lawrence Radiation Laboratory (LRL). A gas such as argon is allowed to leak into the arc chamber. Electrons from a cathode knock off the electrons from the argon atoms, leaving free argon ions. These ions then escape through an axial slit in the arc chamber. The field in the region between the arc chamber and extractor must be shaped in such a way that the ions will not strike the extractor. Various geometries were studied by means of the analog field plotter, until the desired asymmetrical field configuration was obtained.

An account of how this analog field plotter was used in designing epoxy-resin castings for high-voltage transformers, bushings, and potheads is given in *Electrical Engineering*, vol. 75, Dec. 1956, pp. 1104-06.

Special Techniques. When plotting fields associated with complex devices it is sometimes necessary to represent different dielectric constants. This may be done by a technique developed by one of the authors (Park). Those portions corresponding to a dielectric constant of one are represented by a single layer of black conducting paper. Those portions corresponding to higher dielectric constants are represented by additional layers, which may be tacked onto the plotting board with ¼-inch flathead nails around the edges of the paper. For example, epoxy of dielectric constant six is represented by five additional layers.

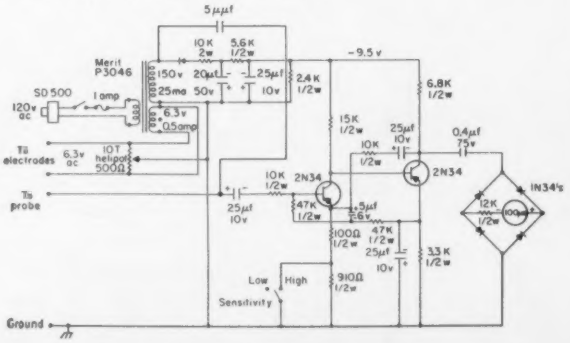


Fig. 3. Circuit schematic of the sensing device

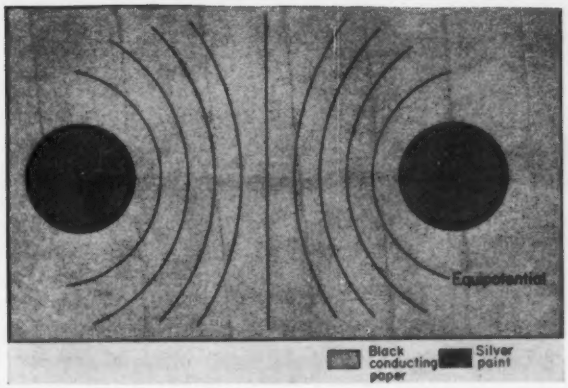


Fig. 4. Electrode geometry for mapping equipotentials between two oppositely charged parallel wires

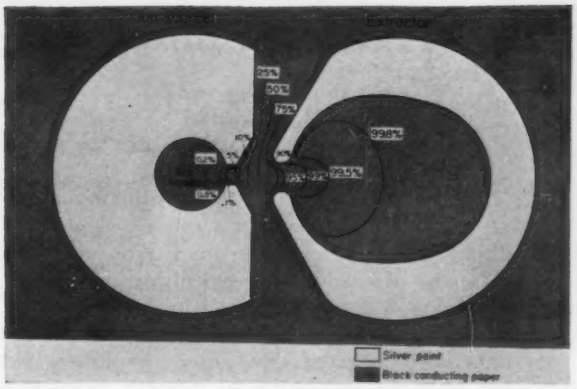


Fig. 6. Plot of the electrostatic field produced in the ion source and extractor of the heavy-ion linear accelerator (courtesy of K. W. Ehlers)

Metallic portions having different conductivities can be represented by using different silver paints of corresponding conductivity or by painting on an appropriate number of additional layers.

Limitations of the Conducting Paper. The conducting papers have been found to have a different resistivity lengthwise with the roll as compared to across the roll. This difference may be as much as 10%. If this is too large an error to be ignored, this anisotropicity can be corrected for by using two crossed layers of the paper to represent a dielectric constant of one.

Any local variations in resistivity of the paper can be corrected for by drawing a smooth curve through the null points.

The conducting sheet should be large enough so that edge effects—distortion of the plot due to the finite boundary—are small.

CONCLUSIONS

THE OVER-ALL ACCURACY of this plotting technique is dependent on the uniformity of the paper, which may vary by as much as 10%. However, the sensing instrument itself is accurate to within 0.05%.

The sensing device described in this article has a number of advantages over commercially available units. Being transistorized, it is smaller and more reliable. By using phase-shifted a-c excitation, it gives a null reading only for a true null point. Perhaps its greatest merit for the engineer who is working in the field, however, is that it is sufficiently inexpensive that he can afford to have one for his exclusive use.

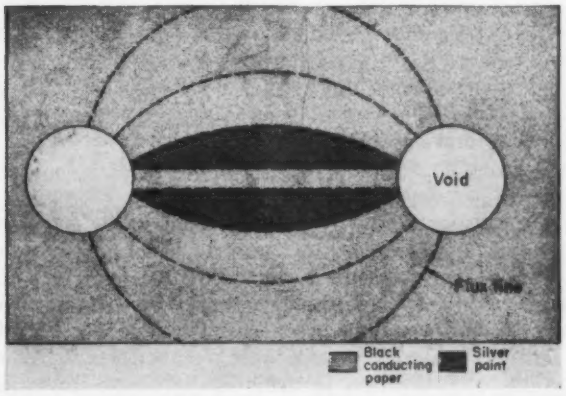


Fig. 5. Electrode geometry and boundary conditions for plotting flux lines between two oppositely charged parallel wires

REFERENCES

1. Analog Simulation (book), W. J. Karplus. McGraw-Hill Book Company, Inc., New York, 1958, ch. 5.

2. Epoxy Resin Casting of Dry-Type High-Voltage Components, C. W. Park. *Electrical Engineering*, vol. 75, December 1956, pp. 1104-06.

3. Analog Methods in Computation and Simulation (book), W. W. Soroka. McGraw-Hill Book Company, Inc., 1954, ch. 9.

4. Use and Theory of the Analog Field Plotter. Sunshine Scientific Instrument Company, Philadelphia, Pa., Instruction Manual IM24.

Crowned by Aluminum

Two hundred electrical transmission tower bases have been "crowned" with aluminum structures by Niagara Mohawk Power Corporation. The composite aluminum-steel towers have a base of steel; the tower tops—"cage," crossarms, and "goathead"—are of aluminum.

Five different designs are being installed by Niagara Mohawk on six separate double-circuit 115,000-volt lines. The lines run from The Power Authority of the State of New York's new Niagara Falls power station, and interconnect with Niagara Mohawk's existing system.

Close to 400,000 pounds of aluminum, an average of almost a ton per structure, were employed in construction of the towers. The aluminum was extruded at Alcoa's Cressona, Pa., works, and fabricated at the Alcoa Structural Division facility there. Subassembly operations were performed by the utility at its Packard substation.

All-Aluminum Transmission Tower Line

A. H. SELLERS
MEMBER AIEE

J. E. WILLIAMS

IN 1960, a double-circuit 220-kv all-aluminum tower line, 2.8 miles in length, was erected as a part of the Philadelphia Electric Company's transmission program for the new Eddystone generating station.

Preliminary design discussions between Philadelphia Electric Company and Aluminum Company of America (ALCOA) indicated that aluminum towers were feasible from the standpoint of strength, fabrication, and erection, but are somewhat more expensive initially than steel. Obviously, a big advantage of aluminum is that it does not require periodic painting.

The area traversed by the line is heavily industrialized with steel mills, oil refineries, a viscose plant, and a coke manufacturing plant, which combine to produce a particularly corrosive atmosphere for steel towers. This appeared to be an ideal location for the use of aluminum in tower construction; hence, an economic study was made to compare over-all costs of aluminum and steel, including the capitalized painting costs.

On the basis that steel towers in this area would require painting at intervals of about 5 years, the economics were in favor of aluminum by a slight margin, even with the higher actual cost of aluminum and an anticipated higher cost of concrete foundations required to compensate for the lighter aluminum towers, in preventing uplift. Aluminum would have been chosen even if the economics had been slightly in favor of steel because of anticipated benefits which were difficult to evaluate, such as lower erection costs for aluminum and the absence of line outages required for painting steel towers.

Three types of towers were designed and used on the line: (1) type *A* suspension tower to be used for angles not exceeding 2 degrees and suitable for 1,000-foot transverse span loadings and 1,200-foot vertical span loadings; (2) type *C* angle-strain tower suitable for 1,000-foot transverse span loadings and 1,600-foot vertical span loadings with 30-degree angle in the line; and (3) type *E* angle-strain tower suitable for dead ends and line angle of 90 degrees with 1,000-foot transverse span loadings and 1,600-foot vertical span loadings.

In general, the towers were designed to support two 220-kv circuits, each consisting of three 795,000-cm 26/7 ACSR (steel-reinforced aluminum cable) conductors in vertical configuration, together with a 190,-800-cm 12/7 ACSR ground wire located over each circuit. The ground wire and conductors were strung to limit the tensions to 6,600 pounds in the former and 10,000 pounds in the latter under load conditions of 1/2 inch of radial ice with an 8-pound-per-square-foot wind load. The transverse and vertical loads were computed on the basis of heavy-loading grade-*B* construction from part 2 on the National Electrical Safety Code, 5th edition; the longitudinal loads were based on the assumption of one ground wire and any one of the conductors on the same side of the tower being broken simultaneously on the *C* tower and all the ground wires and conductors being broken on one side of the *E* tower.

Structural shapes were limited to angles and plates and were made of *6061-T6* aluminum which has good strength (minimum ultimate tensile strength of 38,000 pounds per square inch) and excellent corrosion resistance. Tower bolts were 5/8- and 3/4-inch anodized aluminum alloy *2024-T4*. The structural shapes were produced by the extrusion process and sawed, mitered, and punched by conventional fabrication techniques. Some of the members were formed in the *T4* temper and then heat-treated to the *T6* temper.

Erection of the towers followed normal procedures with some towers subassembled in sections on the ground and raised with a crane, and others subassembled in panels and raised with the use of a gin pole. A normal number of linemen served to erect the tower in the air but fewer men and equipment were required on the ground because of the lightness of the aluminum members. During erection, it was found that the corners of the shapes were easily nicked and that they created sharp burrs and projections which made the use of gloves mandatory. In the future, these sharp corners will be removed by rounding the extrusion dies. Some difficulty was experienced through breaking of the aluminum bolts during erection until torque wrenches were used and the tightening limited to 80% of the minimum breaking strength of the bolt. Tower deflection during stringing was substantially greater than anticipated and caused errors in the conductor sags until the reason for the error was discovered. Towers when erected were geometrically very similar to standard galvanized steel towers and appeared identical except for a somewhat more shiny appearance.

To summarize: the use of aluminum for complete transmission towers results in a structurally sound assembly which is easy to erect and pleasing in appearance. Aluminum eliminates the expense and line outages required for painting. At present, it is competitive with steel from an economic standpoint when used in areas of industrial atmosphere. Further weight reductions will doubtless be achieved by future study and the development of an unlimited variety of structural shapes made possible by the extrusion process.

Digest of paper no. 61-120, recommended by the AIEE Transmission and Distribution Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y. Jan. 29-Feb. 3, 1961. Published in AIEE *Power Apparatus and Systems*, June 1961, pp. 169-73.

A. H. Sellers is with the Philadelphia Electric Company, Philadelphia, Pa.; J. E. Williams is with the Aluminum Company of America, Pittsburgh, Pa.

A Simplified Design of Long-Scale Meters

C. F. VANBENNEKOM

R. M. ROWELL
MEMBER AIEE

THERE HAS BEEN considerable demand for switchboard-type a-c ammeters and voltmeters of sturdy construction, good readability, small size, and low cost, as well as for instruments having uniform pointer positions for given electrical quantities, permitting scale interchangeability and comparison of readings.

Switchboard a-c meters of the long-scale type are now available giving good readability with small panel space. In these 250-degree scale instruments control of scale distribution is a major problem and the use of predetermined printed scales is virtually impossible.

Scale variations arise from several sources: (1) the use of both attraction and repulsion magnetic members; (2) reverse torques causing constriction of upper scale due to close vane spacing; and (3) the sensitivity of the mechanisms to small dimensional variations.

First the attraction members were eliminated, thus eliminating the variation caused by superimposing two torques of different characteristics. This was accomplished by designing the magnetic system for adequate spacing between the wide end of the magnetic repulsion vane and the full-scale position of the moving vane, eliminating reverse-direction torques. Also, the scale length was confined to 180 degrees (5.1 inches), since the worst deviations in scale distribution normally occur between 180 and 250 degrees.

Because major variations in scale distribution may occur from eccentricity of the fixed and moving vanes and changes in the small air gaps between them, the new instruments will have relatively large air gaps. Any decrease in torque has been offset by a larger winding space and a close linkage of magnetic paths outside the active torque-producing area, including a close-fitting case used as part of the magnetic circuit.

The achievement of repeatable concentric relationships between fixed and moving systems at low cost precludes expensive machining to very close tolerances. Referring to Fig. 1, the frame *D* supporting the moving system *A-B-C* is molded with extremely accurate dimensional relationships between the bearing holes and projections which engage the field coil and shield assembly *E*. For further assurance of accurate concentricity a cylindrical projection on the rear bearing of frame *D* enters a molded hole in field-coil spool *F* with a close sliding fit locating the frame with relation to the shield plate and field-coil spool in two parallel and widely separated planes. The shield forms a barrier against external fields and also serves as part of the magnetic circuit providing an accurate mount for the field-coil spool. Its holes for mounting and spool location are punched to very close tolerances, the mounting holes providing an accurate and repeatable relationship with the frame and the case. The field-coil spool is molded into the shield plate. This plate is treated as an insert; thus misalignment is prevented and tolerances due to fastening are eliminated. It will be noted that the same bosses in the die-cast frame that locate the spool and shield plate also locate the assembly concentrically inside the case.

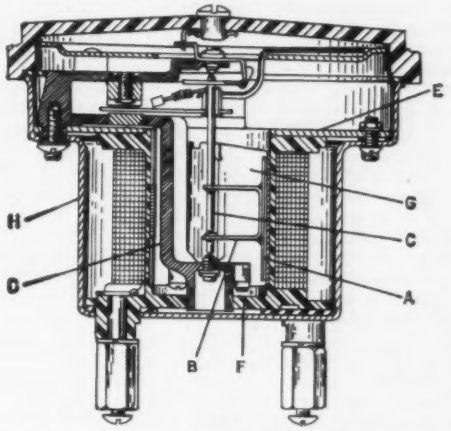


Fig. 1. Sectional view of simplified long-scale instrument

For shockproofing, the case, frame, and spool are secured to each other at both ends, making the structure extremely sturdy. The spool itself is of resilient plastic material having high impact strength.

Another objective in this design is to use multifunction parts. The spool provides support and location for the field winding, positioning of fixed magnetic vane, the centering of the frame and, at the same time, serves as the terminal board. The functions of the shield plate have already been stated. The case serves to support and enclose the mechanism, provides a return path for the magnetic flux and shielding from external fields, and locates the terminal end of the spool.

Not only have mechanical relationships been made very precise, but also the effects of eccentricity, axial deviations, tilt, and angular alignment have been reduced to such an extent that with greatest part and assembly variations expected, deviations of only a few tenths of a per cent will occur.

Torque-to-weight ratios are good (1.1 to 1.2) and the effects of temperature, humidity, and external fields are only a fraction of the limits specified by ASA standards. Ammeter depth is $2\frac{7}{8}$ inches and weight is only 1.9 pounds.

Digest of paper 61-66, "A Simplified Design of Long-Scale Ammeters and Voltmeters," recommended by the AIEE Indicating and Integrating Instruments Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 29-Feb. 3, 1961. Published in AIEE *Power Apparatus and Systems*, Apr., 1961, pp. 85-89.

C. F. VanBennekom and R. M. Rowell are with the General Electric Company, West Lynn, Mass.

INSTITUTE ACTIVITIES

Past President Linder Comments on Standards

C. H. LINDER, Past President of AIEE, in an interview relative to his informal remarks on standards at the Summer General Meeting in Ithaca, N. Y., commented as follows:

"The subject of the Institute's proper contribution to standards work continues at this time to be a matter of particular urgency. Also, the standards-making procedures present an important problem which needs attention.

"As I hoped to stress in my remarks to the Technical Operations Department Forum in Ithaca last June, the standards we have and the machinery by which we get them substantially affect the ability of United States industry to be competitive in the truly world-wide economy which now exists.

Classic Approaches

"The classic approaches to a favorable competitive position are very familiar to United States industry: superior and effective use of materials, ever-increasing productivity, early application of new technology, and improved effectiveness of distribution and consumption of goods. The potential in each of these approaches is greater than ever today, but it must be admitted that we cannot pursue some of them very far without coming up against standards.

"At present there are many and wide differences between United States and foreign standards. Generally those of the United States are the more demanding. They often, for example, specify temperature limits which require use of more material.

"If, then, United States industry is to be world-competitive, factors of reliability, service, and so on should be evaluated in terms of stated wants and needs. When standards do not serve to measure such values, or when they erect requirements which are not rewardable, they must clearly and surely be changed.

Matter of Mechanics

"This brings us to the matter of the mechanics involved in writing standards today—which is a complex matter indeed. AIEE and a number of other professional societies have been deeply involved in standards work for a long time, and have made great contributions. Also in the electrical field, of course, there are the trade-association groups—such as NEMA (National Electrical Manufacturers Association) in the equipment manufacturers' areas of interest, and EEI (Edison Electric Institute) and AEIC (Association of Edison Illuminating Companies) in the fields of operating users' interests.

"When we look at all the standards work being done by all these people, we see a terrifically complicated process for setting standards. There are cases where, in order to get a simple standard established, the matter must pass as many as 9 or 10 decision-making points—at any one of which action may occur which will require starting all over again. In short, we obtain standards only with very high expenditures—in money and in the time of those directly involved.

"I therefore heartily commend to the Institute some extraordinary attention to standards. As a group acting primarily as professional people, AIEE has outstanding qualifications for dealing with the fundamental engineering technologies involved in standards. I would hope that the Institute might be increasingly effective in this role."

Which Institute Technical Groups Do Members of AIEE Want To Join?

IN the May issue of *Electrical Engineering*, on pp. 372-3, a fairly comprehensive report was given of the state of the broad Institute Technical Group (ITG) program. A table indicated the extent of the interest shown in each Technical Committee, as shown by ITG returns, as well as by the 1960 membership interest survey. The number of persons interested in the individual technical committees in that report ranged from 1 to 233.

Member Response

Readers might be curious as to how geographically widespread the interest is in ITGs among the membership. This can be assessed from the fact that, out of 119 Sections, there were 106, some of whose members returned cards or tear-outs as a result of the January 1961 initial announcement.

Since the ITGs were conceived as a means to serve the Institute membership where there is demonstrated interest, it seems appropriate that early promotional efforts should be concentrated on bringing into existence a few of these groups associated with some of the technical committees in which the most active interest has been shown.

With this in mind, the ITG Co-ordination Subcommittee and the six Divisions of the Technical Operations Department are anxious to hear soon from all members who are interested in joining one or

Please add my name to the list of prospective members for the Institute Technical Groups checked below. I understand that I will be billed $4.00 for each group checked as soon as the number of petitioning members reaches 300 for that group.

Communication Division
- ☐ DATA COMMUNICATIONS & TELEGRAPH SYSTEMS

General Applications Division
- ☐ DOMESTIC & COMMERCIAL APPLICATIONS

Industry Division
- ☐ FEEDBACK CONTROL SYSTEMS
- ☐ INDUSTRIAL CONTROL

Instrumentation Division
- ☐ AERO-SPACE INSTRUMENTATION

Power Division
- ☐ POWER GENERATION
- ☐ SYSTEM ENGINEERING
- ☐ TRANSMISSION & DISTRIBUTION

Science & Electronics Division
- ☐ BASIC SCIENCES
- ☐ COMPUTING DEVICES
- ☐ ELECTRONICS

(Send no money)

(Please print)

Signed _____

Address _____

_____

RETURN TO:

AIEE Headquarters
Care of ITG CO-ORDINATION COMMITTEE
345 East 47th Street
New York 17, New York

more of the ITGs appended to the Technical Committees named on the coupon which appears on p. 704.

It will be noted that in the Communication Division there will be a single joint ITG covering the scopes of both technical committees named. In the Industry Division, the ITG promulgated by the Feedback Control Systems Committee is to be called the Automatic Control ITG.

Coupon Should Be Returned

Members who have already sent in other ITG coupons are urged to send this new one also. At Headquarters they will be matched to prevent duplication.

In which one or more of the 11 prospective ITGs would you like to hold membership? Please indicate your desires on the coupon at the bottom of p. 704 and return as promptly as you can to AIEE Headquarters.

Request Due for Nominees of Five Recognition Awards

A request for nominations for the five awards administered by the Recognition Awards Committee will appear in detail in the November issue of *Electrical Engineering*. AIEE members who have new nominations in mind might begin to prepare the biographical material at this time for the following awards:

Medal in Electrical Engineering Education

William M. Habirshaw Award in Transmission and Distribution

Mervin J. Kelly Award in Telecommunication

Morris E. Leeds Award in Electrical Measurement

David Sarnoff Award in Electronics

Nomination forms may be obtained by writing to Mrs. A. L. Landres, Secretary of the Recognition Awards Committee, at Institute Headquarters, 345 E. 47th St., New York 17, N. Y.

Fall General Meeting Scheduled for October 15-20 in Detroit, Mich.

THIS YEAR, the AIEE Fall General Meeting will be held in Detroit, Mich., October 15-20, with headquarters at the Statler-Hilton Hotel. The technical program, inspection trips, and social activities will occupy the entire facilities of the Statler-Hilton during the meeting.

The Detroit Section, host for the meeting, has extended a hearty welcome to all members, their families, and guests. Detroit, the automotive center of the country, is easily accessible by automobile, Great Lakes boat, rail, or air from all parts of the continent.

67 Technical Sessions Planned

Sixty-seven technical sessions are being organized by the 62 technical committees in the six divisions of the Technical Operations Department. Seven of these sessions will comprise the 2nd Annual Symposium on Switching Circuit Theory and Logical Design sponsored by the Computing Devices Committee.

The General Session will be held Monday afternoon, October 16. In addition to an address by AIEE Pres. W. H. Chase, the featured speaker will be G. W. Romney, president of American Motors Corporation. L. C. Mariani, Mayor of the City of Detroit will extend a hearty welcome to the city.

The Recognition Awards Committee has recommended that five awards be presented to three AIEE members and two nonmembers at the General Session. The awards and their recipients are as follows:

Medal in Electrical Engineering Education—G. F. Corcoran (M'35, F'50), professor and chairman of electrical engineering, University of Maryland, College Park, Md.

William M. Habirshaw Award—S. B. Griscom (M'40, F'48) advisory engineer, Electrical Utility Engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Morris E. Leeds Award—T. A. Rich, consulting engineer, General Engineering Laboratories, General Electric Company, Schenectady, N.Y.

Marvin J. Kelly Award—Harry Nyquist (M'24, F'51), retired, Bell Telephone Laboratories, Murray Hill, N.J.

David Sarnoff Award—C. H. Townes, professor of physics, Columbia University, New York, N.Y.

Hotel Reservations

A large block of rooms has been set aside for reservation requests at both the Statler-Hilton and, just across the street, the Tuller Hotel. The hotel reservation card which accompanies the announcement should be used. The room rates per day are as follows:

Statler-Hilton, 1539 Washington Blvd.

Single bedroom	$7 to $13.50
Double bedroom	$13.00 to $17.50
Twin bedroom	$13.50 to $25.00
Suite	$25.00 to $95.00

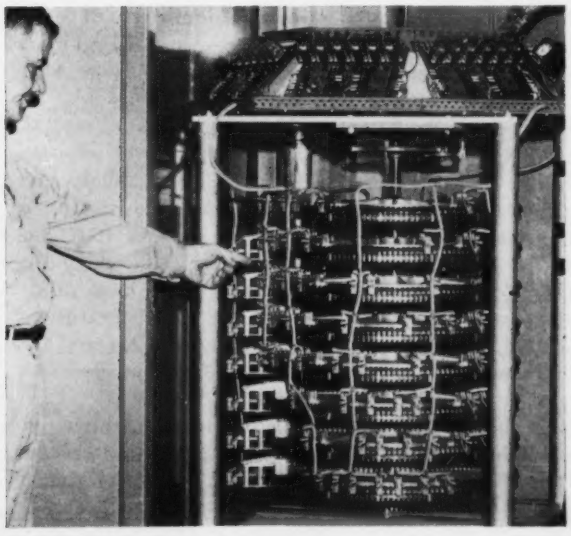
Tuller, 521 Park

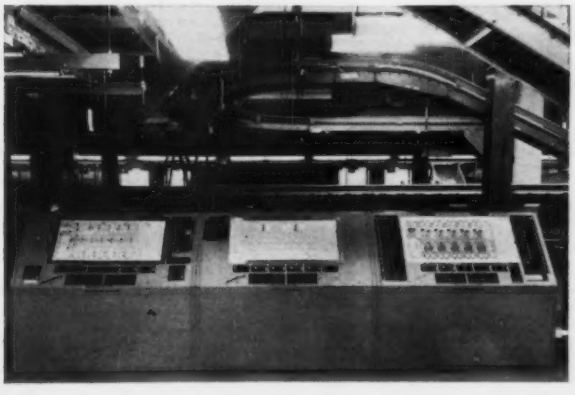
Single bedroom	$5.00 to $12.00
Double bedroom	$8.00 to $12.00
Twin bedroom	$9.00 to $14.00
Suite	$12.00 to $30.00
Room for 3 and 4	$12.00 to $14.00

50th Anniversary Dinner-Dance

The Michigan Section is sponsoring a gala birthday party to celebrate its Golden Anniversary. It will be a fun-filled event at an unbelievably low bargain price.

The party will be held on Tuesday, October 17, at the Latin Quarter in Detroit.





THE Master Graphic Control Panel *(right photo)* in the new Detroit General Post Office will be viewed during an inspection tour to be conducted at the Fall General Meeting. This post office is of major importance to the nation as well as to Detroit and Michigan, because here are assembled the postal machines of the future. The "memory drum" *(left photo)* controls parcel destinations at the post office

A GALA birthday party is planned by the Michigan Section, which will celebrate its Golden Anniversary on Tuesday, October 17, at the Latin Quarter in Detroit (above). A social hour, smorgasbord, a musical show, and dancing to an 11-piece orchestra will be on the program

The low price of $8.50 per person will provide a free social hour, a sumptuous smorgasbord famous in Detroit for its beauty as well as its variety of delicious foods, and a truly outstanding musical show, followed by dancing to an 11-piece orchestra. Tickets will be sold only on receipt of advance payment which must be mailed by October 9.

Those who wish to attend are urged to get their reservations in now for choice table locations and to ensure getting their tickets. Attendance will be limited. Tickets will be held in the attendees' names and distributed at the AIEE registration desk.

Send your check, made payable to AIEE 1961 Fall General Meeting, to: H. R. Williams, The Detroit Edison Company, 2000 Second Ave., Detroit 26, Mich., Room 10 G.O.

Tables seating from 4 to 12 are available, and those wishing complete tables, should send their checks to cover the size of tables desired. Members are advised not to put this off and miss a party they will long remember.

Thursday Evening Party

For the men, their guests, and the ladies —a party with a difference! For an evening of fun, and just for fun, on Thursday, October 19, starting at 8:00 p.m., those attending can test their luck at our "Casino," the likes of which would make Las Vegas and Reno jealous.

In a club atmosphere, everyone may use his skill and his luck to play "like a millionaire" with the poke provided.

The cost of $4.25 each will cover the complete expenses for the evening, including fun, food, and beverages. As the number is limited, each should indicate how many reservations he wants, and they will be held at the Entertainment Desk in the registration area.

Inspection Tours

The inspection trips being planned for the Fall General Meeting are as follows:

Monday, October 16 (8:30 a.m.) Ford Motor Company Rouge Plant. The approximate cost of the trip is $2.00.

Tuesday, October 17 (8:45 a.m.) General Motors Corporation Technical Center. The approximate cost of the trip is $2.00.

Tuesday, October 17 (1:30 p.m.) Michigan Bell Telephone Data Processing Center. The approximate cost of the trip is $2.00.

Wednesday, October 18 (9:30 a.m.) The National Bank of Detroit. No charges will be made for this trip.

Wednesday, October 18 (9:30 a.m.) Greenfield Village and the Henry Ford Museum. No planned inspection trip to these facilities is offered. However, transportation is available for a limited number who may wish to avail themselves of an opportunity to go back in electrical history. These facilities are open to the public the year around. Lunch may be purchased on the grounds in the Garden Terrace or nearby at the Dearborn Inn. The approximate cost of $2.00 is for transportation only.

Wednesday, October 18 (1:00 p.m.) Enrico Fermi Atomic Power Plant. The approximate cost of this trip is $3.00.

Wednesday, October 18 (7:00 p.m.) International Salt Company, Detroit Mine. The approximate cost of this trip is $2.00.

Thursday, October 19 (8:45 a.m.) Chrysler Corporation, Lynch Road Plymouth Plant. The approximate cost of the trip is $2.00.

Thursday, October 19 (1:15 p.m.) University of Michigan, Phoenix Memorial Laboratory. The approximate cost of the trip is $2.00.

Thursday, October 19 (1:39 p.m.) The New Detroit General Post Office. The approximate cost of this trip is $1.00.

Electrical Engineering Completely Restyled Effective with October Issue

IN keeping with the times, and effective with the October 1961 issue, *Electrical Engineering* will be completely restyled from cover to cover. A new format and modern type faces will enable readers to grasp more quickly the import of the presentations and will improve the readability.

The well-known designer and typographical consultant, Franz C. Hess, has been engaged for several months in making layouts, selecting type, and streamlining the design which will emphasize the dignity and distinction of a professional magazine. Mr. Hess, the head of Huxley House, needs no introduction to the advertising fraternity, having been active in the redesigning of several national magazines including *Life* and *Reader's Digest*. He has been honored by the American Institute of Graphic Arts in its "Fifty Books of the Year" awards for design work on behalf of the Metropolitan Museum of Art and has been responsible for the introduction of several modern type faces now widely used.

The editors feel confident that readers will be pleased with the improvement in readability resulting from use of the new type faces and with the effect of unity in the enhanced appearance of the magazine.

AIEE Future Meetings

AIEE-IRE-ISA Joint Nuclear Instrumentation Conference*
North Carolina State College
Raleigh, N. C.
September 6-8, 1961

AIEE-ASME-IRE-AIChE Engineering Management Conference*
Hotel Roosevelt
New York, N. Y.
September 14-15, 1961

Petroleum Industry Conference*
Jung Hotel
New Orleans, La.
September 17-20, 1961

AIEE-ISA-IRE Industrial Electronics Conference*
Bradford Hotel
Boston, Mass.
September 20-21, 1961

AIEE-ASME National Power Conference*
St. Francis Hotel
San Francisco, Calif.
September 24-27, 1961

ECPD 29th Annual Meeting
Sheraton Hotel
Louisville, Ky.
October 2-3, 1961

Middle Atlantic (Fall) Textile Conference*
Barringer Hotel
Charlotte, N. C.
October 5-6, 1961

AIEE-IRE-EIA-SMPTE National Electronics Conference*
Sherman Hotel
Chicago, Ill.
October 9-11, 1961

Fall General Meeting*
Statler-Hilton Hotel
Detroit, Mich.
October 15-20, 1961

Machine Tools Conference*
Faust Hotel
Rockford, Ill.
October 16-18, 1961

AIEE-IRE-U of Nebr. Biomedical Instrumentation and Engineering Conference*
Sheraton-Fontenelle Hotel
Omaha, Nebr.
October 26-27, 1961

Western Appliance Conference
Biltmore Hotel
Los Angeles, Calif.
November 6, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Sept. 1)

AIEE-IRE Nonlinear Magnetics Conference
Statler-Hilton Hotel
Los Angeles, Calif.
November 6-8, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Sept. 1)

NOTICE TO AUTHORS

Strict compliance with the "Author's Guide" will save you time, delays, and unnecessary correspondence. For a copy, write to E. C. Day, 345 East 47 Street, New York 17, N. Y.

AIEE-AIP Magnetism and Magnetic Materials Conference
Westward Ho Hotel
Phoenix, Ariz.
November 12-16, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Sept. 8)

AIEE-IRE-ACM Eastern Joint Computer Conference
Sheraton-Park Hotel
Washington, D. C.
December 10-14, 1961
(Final date for †TP—Sept. 11, ‡CP Syn.—Sept. 26, CPMs—Oct. 6)

AIEE-IRE-ASQC National Symposium on Reliability Control
Statler-Hilton Hotel
Washington, D. C.
January 9-11, 1962
(Final date for †TP—Oct. 11, ‡CP Syn.—Oct. 26, CPMs—Nov. 6)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 28-February 2, 1962
(Final date for †TP—Oct. 30, ‡CP Syn.—Nov. 9, CPMs—Nov. 24)

AIEE-IRE-U of Pa. International Solid-State Circuits Conference
University of Pennsylvania
and Sheraton Hotel
Philadelphia, Pa.
February 15-16, 1962
(Final date for †TP—Nov. 17, ‡CP Syn.—Dec. 8, CPMs—Dec. 19)

AIEE-IRE-AEC-NBS 8th Scintillation and Semi-Counter Conference
Shoreham Hotel
Washington, D. C.
March 1-2, 1962
(Final date for †TP—Dec. 1, ‡CP Syn.—Dec. 15, CPMs—Dec. 26)

Cement Industry Conference
St. Louis, Mo.
April 3-5, 1962
(Final date for †TP—Jan. 3, ‡CP Syn.—Jan. 18, CPMs—Jan. 29)

South Central District Meeting
Hotel Peabody
Memphis, Tenn.
April 4-6, 1962
(Final date for †TP—Jan. 4, DPMs —Jan. 29)

Rubber and Plastics Industries Conference
Sheraton Hotel
Akron, Ohio
April 9-10, 1962
(Final date for †TP—Jan. 9, ‡CP Syn.—Jan. 24, CPMs—Feb. 2)

AIEE-ASME-EIC Railroad Conference
King Edward Hotel
Toronto, Ont., Canada
April 10-11, 1962
(Final date for †TP—Jan. 10, ‡CP Syn.—Jan. 25, CPMs—Feb. 5)

Great Lakes District Meeting
Hotel Van Orman
Fort Wayne, Ind.
April 18-20, 1962
(Final date for †TP—Jan. 18, DPMs —Feb. 9)

Mid-America District Meeting
Hotel Chase
St. Louis, Mo.
April 30-May 2, 1962
(Final date for †TP—Jan. 30, DPMs —Feb. 23)

Middle Eastern District Meeting
Hotel DuPont
Wilmington, Del.
May 7-9, 1962
(Final date for †TP—Feb. 6, DPMs —Mar. 2)

North Eastern District Meeting
Hotel Statler
Boston, Mass.
May 9-11, 1962
(Final date for †TP—Feb. 8, DPMs —Mar. 5)

Joint District Meeting
Erie, Pa.
May 14-16, 1962
(Final date for †TP—Feb. 13, DPMs —Mar. 9)

AIEE-ISA-ARS-IAS National Telemetering Conference
Sheraton-Park Hotel
Washington, D. C.
May 23-25, 1962
(Final date for †TP—Feb. 22, ‡CP Syn.—Mar. 9, CPMs—Mar. 19)

Summer General Meeting
Hotel Denver Hilton
Denver, Colo.
June 17-22, 1962
(Final date for †TP—Mar. 19, CPMs —April 11)

AIEE-AIChE-IRE-ISA-ASME Joint Automatic Control Conference
New York University
New York, N. Y.
June 27-29, 1962
(Abstracts due Oct. 15, Final text due Nov. 15)

IFIPS Congress
Munich, Germany
August 27-September 1, 1962
(Abstracts due Sept. 15)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

8th Petroleum Industry Conference Slated for September 17-20 in New Orleans

THE 8th Electrical Conference of the Petroleum Industry will be held September 17-20 at the Jung Hotel in New Orleans, La.

There is much to interest those who come to New Orleans, a popular convention city. The Vieux Carre provides old-world charm. The Port of New Orleans, second busiest in the United States, is typical of modern progress. Bourbon Street provides the "joie de vivre." Within a radius of 100 miles are vast reserves of natural resources, including oil, gas, salt, and sulphur. The fishing resources are extensive.

The Jung Hotel, headquarters for the conference, has allotted a full complement of rooms. Rates are as follows:

Single room	$8 to $10
Double room	12 to 14
Twin rooms	13 to 16
Suites	23 and up

Registration will take place in Lounge No. 1 on Sunday at 4 p.m. to 7 p.m., and Monday through Wednesday from 8 a.m. to 4 p.m.

Authors' breakfasts will be held at 7:30 a.m. on Tuesday and Wednesday mornings in Room No. 3. Authors of papers presented on Monday are invited to breakfast on Tuesday morning. Authors of papers presented Tuesday and Wednesday mornings are invited to breakfast on those respective mornings.

A cocktail hour and dinner will be held Tuesday evening, September 19. This high point of the social activities of the conference will be in keeping with the famous New Orleans tradition of hospitality. Music during and after dinner will be provided by Russ Papalia and his orchestra.

Inspection Tours Planned

Inspection trips will be made Tuesday at 12:00 noon to the following places:

Marshland Oil Field. South Louisiana has a petroleum productivity per square mile higher than any similar region in the United States. The producing sands are at depths of approximately 10,000 feet. The fields are characterized by isolation from land transportation and conventional utilities. The tour will include visits by boat to typical well heads, production facilities, field compressor stations, and drilling rigs.

New Orleans Sewerage and Water Board. The City of New Orleans is in the unique position of being required to lift all of its rainfall by pumps to an elevation above Gulf level to effect drainage. This is performed by a complex of generating plants, an independent power distribution system, and 12 electric motor-driven pumping plants involving some 60,000 hp capacity, and designed for the utmost in reliability. The technique and designs are unconventional and interesting.

Shell Oil Refinery. This refinery 20 miles above New Orleans has been progressively modernized to keep abreast of processing technology. The trip will include stops at tanker-loading facilities and a lease automatic custody transfer facility in a producing field near the refinery.

Offshore Oil Development Operations (Film). Available time, erratic weather, and transportation complexities have prevented scheduling of inspection trips into the Louisiana offshore area. However, a program of films has been arranged covering offshore construction, the development and use of an offshore drilling unit capable of operating in 100-foot-marker water depths and the combating of an offshore well fire.

Room No. 4 will be reserved as a Hospitality Room for ladies' activities. Coffee will be served morning and afternoon. Bridge tables and cards will be available. Tickets for all ladies' activities will be obtainable at the Registration Desk.

On Monday, the Hospitality Room will open for ladies at 10:00 a.m., and the general luncheon will be served at noon in the Charcoal Room. At 2:00 p.m., the ladies will be conducted on a Grey Lines bus tour of New Orleans, which will provide an opportunity to see famous historical landmarks.

Breakfast at Brennan's will be held Tuesday at 10:00 a.m. At 1:00 p.m., a walking tour of the Vieux Carre is scheduled. French and Spanish architecture will be seen along with patios, antique shops, the St. Louis Cathedral, and Jackson Square.

The ladies will take a sightseeing river trip on Wednesday at 10:00 a.m., on the *Good Neighbor*, a sightseeing vessel operated by the Port of New Orleans from which can be seen many of the thousands of ocean-going vessels which use the port annually.

Attendance fees are as follows:

Registration	
AIEE members	$8
Nonmembers	10
Ladies and students	no charge
Monday General Luncheon	4
Tuesday Cocktail Hour and Dinner	8
Inspection Trips	3

The conference is sponsored by the Petroleum Industry Committee of AIEE and the New Orleans Section, AIEE.

The New Orleans conference committee is composed of: Chairman—W. D. Stroud, Okonite Company; Vice-Chairman—E. S. Dobbs, Bedell and Nelson, engineers; Secretary—M. L. Hustell, New Orleans Public Service, Inc.; Printing and Program—J. W. Barnes, Mid-South Sales Co., Inc.; Technical—Todd Sutton, General Electric Company, Baton Rouge; Publicity—L. B. Davis, Westinghouse Electric Company; Banquet—Jim Warren, I-T-E Circuit Breaker Company; Registration and Hotel—J. P. Hynds, Westinghouse Electric Company; Finance and Budget—Leonard Ramon, New Orleans Public Service Inc.; Student Activities—Jim Cronvich, Tulane University; Arrangements—C. P. Knost, Moloney Electric Company; Reception—Harold Deloney, Louisiana Power and Light Company; Inspection Trips—Stanley Bird, California Company, and Ladies Activities—O. E. Barron.

Tentative Program Given

The tentative program for the conference follows:

Monday, September 18

10:00 a.m. General Session

Opening Remarks—W. D. Stroud, conference chairman

Invocation—Rev. Clyde Frazier, minister, Lake Vista Methodist Church

Welcome—Mayor deL. S. Morrison of New Orleans, La.

Keynote Address—K. H. Shaffer, president, California Co.

12:00 noon General Luncheon

Presiding—Seymour Cambias, chairman, New Orleans Section AIEE

Speaker—G. C. Rawls, president, Louisiana Power & Light Co.

2:00 p.m. General Technical Session

Electronic Instrumentation and Control in the Petroleum and Petrochemical Industry

Presiding—Jules Jacquin, Dow Chemical Co.

CPA61-5002. Electronic Instrumentation—Past, Present and Future. *P. Drinker, V. V. Tivy,* Foxboro Co.

CP61-991. Considerations in the Selection of D. C. Control Signals. *D. T. Cusack,* Hagan Chemicals & Controls

CPA61-5003. Factors in the Choice of Process Instrumentation—A Consultant's Viewpoint. *Ward O'Connor,* Lummus Co.

CPA61-5004. Electronic Control of an Electric Reforming Furnace. *A. A. Johnson,* Dow Chemical Co.

5:00 p.m. Subcommittee meetings

Manufacturing

Production

Transportation

Tuesday, September 19

8:30 a.m. Subcommittee Technical Sessions —Subcommittee Chairmen Presiding

PREPRINT PRICES

50¢ to Members.
$1.00 to Nonmembers.

ALL MAIL ORDERS must be accompanied by remittance in full or coupons.

COUPON BOOKS in $10 denominations may be purchased.

NUMBERED PAPERS only are available.

SEND ORDER and remittance to:
AIEE Order Department
345 East 47th Street
New York 17, N. Y.

Manufacturing

G. H. St. Onge, Presiding

CP61-990. Refinery Power System Planning for Serving Large Motor Loads. *G. W. Cunningham*, General Elec. Co.

CPA61-5005. Economics of Selection of Large Motor Drivers and Problems in their Application. *R. E. Daze, H. C. Mayo, J. A. Stewart*, M. W. Kellogg Co.

CP61-1001. Static Excitation for Synchronous Motors. *E. R. Hoyle, M. N. Halberg*, General Elec. Co.

Production

W. E. Withers, Presiding

CPA61-5006. Progress in Electrification of Land Drilling Rigs. *J. P. Wagnon*, Parker Drilling Co.; *G. W. Webb*, General Elec. Co.

CPA61-5007. The Ability of Contacts in Low Current Control Systems to Cause Ignition of Hydrocarbon-Air Mixtures. *R. S. James*, U. S. Dept. of Interior

CP61-995. General Aspects in the Automation of Offshore Oil and Gas Production. *H. D. Gant*, Axelson-Garrett Div. of U. S. Industries

Transportation

J. J. Sonnier, Presiding

CPA61-5011. Automation of Gas Transmission Through Digital Control. *D. C. Washburn*, Westinghouse Elec. Corp.

CPA61-5012. Design and Operation of Automatic Control for Longview Compressor Station of Texas Eastern Transmission Company. *F. P. Gertson, A. G. Fitch*, Texas Eastern Transmission Co. and Westinghouse Elec. Corp.

CP61-992. Electrical Design Features of Mid-America Pipe Line. *G. E. Mace*, Mid-America Pipe Line Co.

Protective Relay Setting and Co-ordination for Pipe Line Pumping Stations. *O. F. Zedler, Jr., L. U. Eidson*, Humble Pipeline Co. and Westinghouse Elec. Corp.

6:30 p.m. Cocktail Hour

7:30 p.m. Dinner

Wednesday, September 20

9:00 a.m. Subcommittee Technical Sessions —Subcommittee Chairmen Presiding

Manufacturing

G. H. St. Onge, Presiding

CP61-994.Application of the Electric Tracing in Petroleum and Chemical Plants. *R. G. Medley, W. A. Shafer*, Union Carbide Chemicals Co.

CPA61-5001. New Static Devices Applied With Switchgear. *E. R. Brucklacher*, Allis-Chalmers Mfg. Co.

CP61-999 Train and Develop Your Electronic Instrument People. *N. A. Anderson*, Foxboro Co.

CPA61-5000. Control of a Petroleum Process Unit with a Large Scale Digital Computer. *E. N. Ply, A. D. Pendleton*, Amer. Oil Co. and IBM

Production

W. E. Withers, Presiding

CP61-1002. User's Experience with Inherently Protected Motors. *Frank Beach, Frank Best*, Cities Service Petroleum Co.

CPA61-5008. A 440/762 Volt Oilfield Combination Starter. *T. L. Scott*, Phillips Petroleum Co.

CPA61-5009. Lightning Protection for Oil Field Equipment. *J. K. Howell*, Westinghouse Elec. Corp.

CPA61-5010. Maintenance of Lease Electric Equipment. *H. H. Halderson*, Phillips Petroleum Co.

Transportation

J. J. Sonnier, Presiding

CP61-996. Computer Application to Dispatching. *T. C. Heard*, General Elec. Co.

CPA61-5015. Methods of Economic Valuation. *S. R. Evans*, Shell Pipe Line Corp.

CPA61-5013. Digital Telemetering for Pipe Line Systems. *P. D. Woodruff*, General Elec. Co.

CP61-997. Technicians for a Remotely Operated Pipe Line. *A. R. Heidebrecht, F. S. Jones*, Platte Pipeline Co.

12:00 noon Joint Planning Group Luncheon

2:00 p.m. General Technical Session

Computer Control in the Petroleum and Petrochemical Industry

Presiding—E. B. Turner, Secretary, Petroleum Industry Conference.

CP61-998. On-Line and Off-Line Computer Applications in the Petroleum Industry. *J. F. Moore, F. R. Currie*, Bonner & Moore Engineering Associates

CP61-1000. Tying the Digital Control Computer to an Industrial Process. *W. M. Gavies, W. N. Patterson*, General Elec. Co.

CPA61-5005. A Mobile Logger Using Magnetic Tape for Digital Data Storage. *M. O. Bird, J. F. Draffen*, Monsanto Chemical Co.

CP61-1003. On-Line Computer Control. *W. C. Johnston*, Universal Oil Products Co.

CP61-993. Electrical Features of an "On-Line" Computer Control System for a Petro-Chemical Process. *C. H. Thurman*, Monsanto Chemical Co.

5:00 p.m. Petroleum Industry Committee Meeting

Thursday, September 21

8:00 a.m. Executive Committee Meeting

Winners of District Prize Papers Published in *Transactions* Announced

WINNERS of the District prizes for the best paper of 1959-60, published in the *Transactions* and prepared by a resident of the District, have been named. The first prize consists of a certificate and $75, and the second prize, a certificate and $50.

Recipients of these awards and the titles of the winning papers are as follows:

District 1
First Prize—An Analysis of Solid Rotor Machines (4 papers). *A. J. Wood, C. Concordia*
Second Prize—The Calculation of Attenuation Constants for Radio Noise Analysis of Overhead Lines. *G. E. Adam, L. O. Barthold*

District 2—No awards

District 3
First Prize—Strategy for Expansion of Utility Generation. D. N. Reps, J. A. Rose
Second Prize—An Analysis of Transfer in Gas Shielded Welding Arcs. *W. J. Greene*

District 4
First Prize—A Circular Polarization Duplexer for Millimeter Waves. *R. G. Fellers*
Second Prize—A New Impulse Metering System. *C. J. Snyder, C. A. Booker, Jr.*

District 5
First Prize—Theory of Economic Selection of Generating Units. *K. L. Hicks*
Second Prize—Inductors Biased with Permanent Magnets—Part II. *J. T. Ludwig*

District 6
First Prize—Omaha Public Power District 161 KV Substation Design. *H. C. Sampers*
Second Prize—Wire Line and Carrier Communications on the Union Pacific Railroad. *J. O. Jett*

District 7
First Prize—A New Method of Making Transmission Loss Formulas by Means of Eigenvalues and Modal Matrices. *E. E. George*
Second Prize—Investigation of the Feasibility of Designing Howing Aircraft Flight Control Systems for Minimum Probabalistic Error. *Z. Zaborszky, J. W. Diesel*

District 8
First Prize—A Non-Destructive Break-Down Phenomenon in Selenium Rectifiers. *A. C. English, W. H. Tobin*
Second Prize—Instrument Servomechanisms With Backlash, Coulomb Friction and Stiction. *M. P. Pastel, G. J. Thaler*

District 9
First Prize—New Distribution Substations for Direct 230 KV to 12 KV transformation on the B. C. Electric Company System. *M. B. Callander*
Second Prize—Telemetering Applications and Operating Experience on a Large Power System. *D. E. Johannson*

District 10
First Prize—Magnetic Flux Pattern Instrumentation Using Hall Probes. *Herbert Hollitscher*
Second Prize—No Award

District 11
First Prize—The Magnetic Analog, With Spiral Search Coils. *A. D. Moore*
Second Prize—Instrumentation for the Diagnosis of Coronary-Artery Disease. *D. F. Moyer, G. D. Talbot*

District 12
First Prize—Magnetization in Tape Wound Cores. *R. C. Barker*
Second Prize—Some Characteristics of Audible Noise of Power Transformers and Their Relationship to Audibility Criteria and Noise Ordinances. *R. J. Ringlee, M. W. Schulz, Jr.*

District 13—No Award

District 14
First Prize—Strategy for Expansion of Utility Generation. *D. N. Reps, J. A. Rose*
Second Prize—Analytical Studies of the Brushless Excitation System. *R. W. Ferguson, R. Herbst, R. W. Miller*

APPEARING in front of the Paper Technology entrance to McCracken Hall at Western Michigan University are members of the General Conference Committee of the 1961 Pulp and Paper Industry Electrical Engineering Conference. They are: *(left to right, in foreground)* Homer Earle, director, Division of Field Services, Western Michigan University; K. P. Grenfell, General Electric Company, Schenectady, N. Y., Program Review Committee chairman, and D. B. Gearhart, General Electric Company, Kalamazoo, Mich., Local Arrangements Committee of the 1961 conference. Those standing in the background are unidentified

Pulp and Paper Industry Conference Conducted at Western Michigan University

SOME 150 engineers attended the 7th Annual Conference on Electrical Engineering as Applied to the Pulp and Paper Industry, held June 21-23 at Western Michigan University in Kalamazoo, Mich.

Inspection trips were conducted to the nearby paper mills and other nationally known firms, which produce a variety of products such as pharmaceutical supplies, and musical and fishing equipment. A Fourdrinier machine located on the campus produces most of the university's paper requirements.

Separate committee meetings of the AIEE Pulp and Paper Subcommittee and the Electrical Engineering Committee of the Canadian Pulp and Paper Association were held Wednesday, June 21.

During the AIEE Subcommittee meeting, Atlanta, Ga., was selected as the location for the 8th annual meeting, tentatively arranged for the third week in May, 1962. R. P. Derrick of Westinghouse Electric, Pittsburgh, Pa., was appointed Program Review chairman, along with W. S. Hines of Westinghouse, Atlanta, who will serve as Local Arrangements chairman. C. B. White of the Allis-Chalmers Manufacturing Company, Norwood, Ohio, was appointed Publicity Committee chairman, and A. C. Cook, General Electric Company, Cincinnati, Ohio, was appointed to serve with the Publicity Committee.

Dr. Robert Diehm of Western Michigan University spoke Thursday morning, June 22, on "Engineering Developments In Paper Making." Dr. Diehm pointed out that lots of timber is going to waste faster than it is being used. He also said that the helicopter could be used economically in logging many areas inaccessible for the conventional means of removal to the mill.

Data Processing Seminar

During the Data Processing Seminar on Thursday, R. P. Derrick of Westinghouse Electric discussed the types and methods of data logging along with the many instruments now available or under design, which may be utilized in measuring paper machine variables. Mr. Derrick stated these variables may be "read out" periodically in a data accumulating process. Mr. Derrick also discussed "process computer control" systems involving calculated results from the measured variables. These systems, Mr. Derrick said, are not prohibitively expensive, and computers in general should add 8.5 million people to the working force.

Mr. Derrick was followed by W. Mikelson of the General Electric Company, who explained that the use of data logging and computer equipment is in an early stage of development and that the terminology used is not yet standardized. He stated that "the computer is really simple, and when compared with human ability has the capability of a fourth grader." Mr. Mikelson declared that the large scale memory or storage capacity of the computer is used to great advantage due to the speed at which it may be utilized in scanning its memory. Mr. Mikelson also described the many new techniques utilized in computer systems.

The third member of the Data Processing Seminar was H. S. Ogelsby of the St. Regis, Jacksonville, Fla. Mr. Ogelsby, in his discussion of "Applications," asserted that rising costs in the paper industry are being compared to selling prices, but not at the same rate. He advised that a cautious approach should perhaps be made in the automation of the industry.

The Thursday luncheon was addressed by Dr. John Cruze, director of Summer School at Western Michigan University.

Dwain Bates of Potlatch Forest joined the Data Processing Seminar with a resumé of the study of an International Business Machines' computer application of their Lewiston operation. Mr. Bates said that the purpose of this study is to predict quality during operation and to minimize off grade material. He advised that data processing should not be initiated "without specific purpose and an organized set of data."

The afternoon session closed with the presentation of a paper on "Boiler Flame-Out Control," given by P. K. Ryder of the Electronics Corporation of America.

Banquet Held

A banquet in the evening was highlighted by a humorous account of "Bends and Breaks" by Rice Kello of Investors Division Services, Evansville, Ind.

The third day of the conference began with the presentation of a paper on "The Application of Instantaneous-Trip Circuit Breakers in Motor Control Centers" by C. Rice of the Allen-Bradley Company, Milwaukee, Wis. Mr. Rice discussed the magnetic trip circuit breaker as it is used in "Combination" type starters when coordinated with the magnetic starter to provide short-circuit and overcurrent protection for electric motors.

A panel discussion on "D.C. Motor and Generator Insulation" prompted a question and answer discussion between a panel of experts, representing paper mills and electrical manufacturers, and the audience. The moderator for this panel was J. S. Kirkland, Rome Kraft Company, who is secretary of the AIEE Subcommittee. Representatives on the panel were: D. E. Bivens, Jr., Olin Mathieson Chemical Company, West Monroe, La.; H. Murdock, Allis-Chalmers Manufacturing Company, Norwood, Ohio; P. T. Schuermann, General Electric Company, Schenectady, N.Y.; A. G. Posluszny, Westinghouse Electric, Buffalo, N.Y., and W. Stiffler, Reliance Electric and Engineering Company, Cleveland, Ohio.

This panel discussion resulted in agreement that the d-c motor and generator is being steadily improved as a result of research and new development in the area of improved organic varnishes and protective coatings employing polyester and epoxy.

This conference was jointly sponsored by the Pulp and Paper Subcommittee of AIEE, the Western Michigan Section of AIEE, and the Department of Paper Technology, Western Michigan University.

Nuclear Instrumentation Symposium Scheduled September 6-8 at Raleigh, N.C.

THE 1961 Joint Nuclear Instrumentation Symposium is scheduled for September 6-8 at North Carolina State College in Raleigh, N. C. The meeting is sponsored by the Nuclear Committees of AIEE, the Nuclear Industry Division of the Instrument Society of America, and the Professional Groups on Instrumentation and Nuclear Science of the Institute of Radio Engineers.

Tentative Technical Program Announced

The tentative program for the symposium follows:

Wednesday, September 6

8:30 a.m. Registration

Morning Session—Research Instrumentation and New Devices

Reactor Power Monitor Utilizing Cerenkov Radiation. *J. L. Lowvorn*, Oak Ridge Nat'l Lab.

High Current Regulated Supply for the Oak Ridge Cyclotron Combining Transistors and Magnetic Amplifiers. *W. H. White, Jr., B. C. Behr, W. E. Lingar*, Oak Ridge Nat'l Lab.

Application of Silicon Radiation Detectors. *LeConte Cathey*, Dupont—Savannah River Lab.

A Sub-millimicrosecond Current Amplifier Utilizing an Unusual Transistor Effect. *F. T. May, R. A. Dandl*, Oak Ridge Nat'l Lab.

Afternoon Session—Space Instrumentation

Survey of Space Nuclear Instrumentation. *G. Ludwig*, Goddard Space Center

Gamma Ray Astronomy in Space in the 50KEV to 3MEV Region. *L. Peterson*, Univ. of Minn.

Instrumentation for Measurements in the Van Allen Belts. *W. Wheltley*, Univ. of Iowa

University of Chicago Cosmic Ray Experiments above 0.5MEV in Space. *J. Lamport*, Univ. of Chicago

Thursday, September 7

Morning Session—Surveys of the State of the Art

Our Changing Views of Reactor Instrumentation. *A. R. Pearson, C. G. Lennox*, Atomic Energy of Canada

A Survey of Instrumentation in Particle Accelerators. *W. A. Higgenbotham*, Brookhaven Nat'l Lab.

British Review Paper. (To be announced later)

Capability of Safety Systems for Destroying Reactors. *E. P. Epler*, Oak Ridge Nat'l Lab.

Afternoon Session—Plasma Research Instrumentation

A Survey of Plasma Instrumentation. *C. Wharton*, Univ. of Calif. Radiation Lab.

The Use of Electrostatic Probes in Plasma Physics. *F. F. Chen*, Princeton Univ.

Diagnostic Instrumentation in the UCRL Plasma Research Program. *W. F. Cumming*, Univ. of Calif. Radiation Lab.

DCX Instrumentation. *Herman Postma*, Oak Ridge Nat'l Lab.

Soft X-Ray Plasma Diagnostics. *F. C. Jahoda*, Los Alamos

7:30 p.m. Banquet

Friday, September 8

Morning Session—Process and Monitoring Instrumentation

A Continuous Photometer for Low Concentration of Uranium in Aluminum Nitrate-Nitric Acid Solutions. *C. M. Slansky, E. E. Erickson*, Philiips Petroleum (National Reactor Testing Site)

In-line Gamma Monitor, Uranium Colorimeter. *J. W. Landry*, Oak Ridge Nat'l Lab.

Savannah River Laboratory Criticality Incident Alarm System. *J. N. Wilson*, Dupont—Savannah River Lab.

Failsafe A-C High Low Limit Detector. *E. A. Bianchi, P. Lenk*, Stromberg-Carlson

Fast Response Monitor for Airborne Uranium Dust. *W. O. Gentry, G. B. Seaborne*, Oak Ridge Gaseous Diffusion Plant

Effect of Thermal Neutron Irradiation on Thermocouples and Resistance Thermometers. *C. W. Ross*, Leeds & Northrup

Afternoon Session—Design of Systems and Instruments

Digital Computers for Use in Nuclear Power Applications. *J. Prades, Y. Panis*, Ramo-Wooldridge

Automatic Self-Testing of Reactor Monitoring System. *D. Fitzgerald*, Bendix

Criteria for Transistorization. *E. B. Hubbard*, General Elec.

Nuclear Systems Design for Reliability. *J. L. Cockrell, J. H. Magee, V. S. Underkoffler*, Leeds & Northrup.

Registration Information Given

Registration information follows:

	Registration (After August 28)
Members of Sponsoring Societies (Including educators)	$20.00
Students (*Proceedings* $2.50 Extra)	3.00
Nonmember	25.00
Banquet and Social Hour	6.00

A bound set of **Proceedings** will be furnished to registrants.

Housing accommodations will be available at $2.00 per night per person for double occupancy in a modern dormitory on the campus. Meals will be served to meal-ticket holders in the cafeteria located in meeting facility. Since the Debutante Ball will be held in Raleigh during the time of the Symposium, it is especially important to pre-register and make reservations early.

Checks should be made payable to the Joint Nuclear Instrumentation Symposium. Further information may be obtained by writing to: C. S. Lisser, Steering Committee chairman, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 345 East 47th Street, New York 17, N.Y.

Bronze Bell Commemorates Service

A BRONZE BELL, commemorating 30 years' service as a counselor to the Michigan College of Mining and Technology student branch of AIEE, was presented to Dr. G. W. Swenson (*left*), former professor and head of the electrical engineering department at Michigan Tech, by V. O. York (*right*), professor of electrical engineering and faculty advisor for the student chapter of AIEE. The gift was authorized by the North East Section of AIEE and presented to the Michigan Tech student chapter of AIEE to commemorate Dr. Swenson's long term of service to the organization. Accompanied by a gavel, the bronze bell will be used to open and close meetings of the professional society

AIEE President Inspects UEC

AIEE President W. H. Chase inspects the air-conditioning unit on a floor to be occupied by the Institute in the new United Engineering Center (UEC). The United Nations Building is seen through the window

Ross Photo

Engineers Joint Council Schedules 1962 Nuclear Congress and Atomic Exposition

PUBLIC aspects in the use of nuclear energy, as well as engineering and operational problems within the nuclear industry, will highlight discussions at the technical sessions of the 1962 Nuclear Congress and Atomic Exposition.

This has been announced by Lombard Squires of the E. I. du Pont de Nemours & Co., Inc., general chairman of the event, which will be held June 4-6, 1962, in the New York Coliseum under sponsorship of the Engineers Joint Council, Inc. (EJC).

J. C. Woodhouse of the E. I. du Pont de Nemours & Co., Inc., Program Committee chairman, said the technical sessions will be divided into the following major areas: Public Aspects of Nuclear Use, Problems of Advanced Reactors, Nuclear Education for Engineers, Computational Problems in the Nuclear Industry, Application of Atomic Physics for Tests of Materials, Instrumentation, Testing Methods, Radiochemical Separation, Fuel Cycling and Nuclear Safety.

The Program Committee adopted the following definition of the objective of the Nuclear Congress and Atomic Exposition:

"The 1962 Nuclear Congress and Atomic Exposition will provide professional engineers and management with an up-to-date review of engineering problems in the nuclear field. It will provide state of the art presentations and authoritative reviews by well-qualified and active participants in the application of engineering to nuclear problems. Major attention will be focused on the status of civilian power reactions on the impact on the public of nuclear reactor and radiochemical processing plants and to the major issues now facing the nuclear industry."

The Congress manager for the 1962 event is Newell Appleton of the American Institute of Mining, Metallurgical and Petroleum Engineers.

The Reber-Friel Company of Philadelphia, nationally known exhibit management firm which has managed all the previous Atomic Expositions will be in charge of the exhibits for the 1962 event. Floor plans and other exhibit information are now being readied for distribution to the nuclear industry. Firms wishing to receive these materials may write to the Reber-Friel Company at 117 S. 17th St., Philadelphia 3, Pa.

Members of the Program Committee of the 1962 Nuclear Congress and Atomic Exposition, in addition to Mr. Squires and Mr. Woodhouse, are:

J. G. Terrill, Jr., and J. H. Fooks, both representing the American Society of Civil Engineers; W. D. Manly and B. W. Dunnington, both of the American Institute of Mining, Metallurgical and Petroleum Engineers; F. D. Acker of the American Society of Mechanical Engineers; D. B. Preston of the American Water Works Association; J. G. Lundholm of AIEE; N. J. Palladino, the American Society for Engineering Education; Bernard Manowitz, the American Institute of Chemical Engineers; Col. W. C. Gribble, Capt. F. F. Kravath, and Lt. Comdr. E. M. Saunders, all with the Society of American Military Engineers; D. B. Sloan, the American Institute of Consulting Engineers; M. A. Cordovi, the American Society for Testing Materials; T. P. Schoonmaker, the American Welding Society; Hanson Blatz, the American Public Health Association, and Carson Dalzell of the Atomic Energy Commission who is serving as vice-chairman of the Program Committee.

Former Vice-President Joins AIEE Headquarters Staff

J. L. Callahan (AM '21, F '48) joined the AIEE Headquarters Staff on July 1, 1961, as Assistant to the Executive Secretary. Mr. Callahan's immediate assignment will be in staff services relating to the translation of foreign technical publications and membership development.

Mr. Callahan retains a consulting relationship with the Radio Corporation of America (RCA). He was Administrator of the Rocky Point Long Island group of RCA Laboratories until its recent discontinuation.

Mr. Callahan has held major offices and committee chairmanships in the New York Section of AIEE and the Institute. He has been Chairman of the New York Communications Division (1940-1941) and Section Chairman (1945-1946). He served as Chairman of the Institute Communications Committee (1947-1948). In 1948, he was elected Vice-President from District No. 3 and was again returned to the Board of Directors in 1956 as Chairman of the Admissions and Advancements Department.

Mr. Callahan is a Fellow of the Institute of Radio Engineers, in which he has held numerous committee and professional group posts. He is a fellow and has been active in the Radio Club of America, which he served as president in 1941.

Mr. Callahan's extensive AIEE background also includes service on the following Committees: Standards, Technical Program, Edison Medal, Planning and Coordination, Student Branches, Publications, and the Board of Examiners.

J. L. Callahan

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"RADIO ENGINEERING" REVIEW

R. D. Campbell, Amer. Tel. & Tel. Co.
195 Broadway, New York 7, N.Y.

"RADIO ENGINEERING AND ELECTRONICS" REVIEW

L. S. Schwartz, NYU College of Engineering,
181st St. & Univ. Ave., New York 53, N.Y.

SPACE COMMUNICATION

H. E. Weppler, American Tel. & Tel. Co.,
195 Broadway, New York, N.Y.

"TELECOMMUNICATIONS" REVIEW

H. F. May, Bell Tel. Labs., Whippany, N.J.

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Facilities Planning, Corning, N.Y.

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P. O. Box 209, Madison, N.J.

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6901 Elmwood Ave., Philadelphia 42, Pa.

SOLID STATE DEVICES

H. W. Henkels, Westinghouse Elec. Corp.,
Semiconductor Dept., Youngwood, Pa.

AIEE Receives Grant To Provide Translation of Russian Technical Journals

RECEIPT of a grant from National Science Foundation covering the translation and publication of the 1961 monthly issues of three Russian technical journals has been announced by N. S. Hibshman, Executive Secretary of AIEE. The journals are: *Radio Engineering (Radiotekhnika), Radio Enginereing and Electronic Physics (Radiotekhnika i Elektronika),* and *Telecommunications. (Electrosvyaz).*

A contract has been placed with the International Division of Royer and Roger, Inc., 41 East 28th Street, New York 16, N.Y., covering the translation, editing, publication, and distribution of the English issue. The Royer and Roger effort for AIEE will be under the direction of the Headquarters staff supported by three special Review Committees organized by the Communication Division.

Selected reviews of the translated articles prepared by the Communication Division Review Committees will appear monthly in the Russian Translations Section of *Electrical Engineering.* The membership of the committees include specialists in the fields covered by the three Russian journals in order to afford critical appraisals.

Translated issues of the three Russian journals have been released to subscribers as follows: *Radio Engineering*—January, February, March, and April; *Radio Engineering and Electronic Physics*—January and February, *Telecommunication*—January, February, March, and April.

Translated Tables of Contents of the most recent issues received from Russia now in process at Royer and Roger are as follows:

Radio Engineering

No. 5, May 1961

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A. L. Fel'dshteyn, Coupled Nonuniform Lines

V. Klezha, Application of the Principles of Nonlinear Filtering to the Theory of Reception of Telegraph Signals

B. V. Telov, Computing the Spectrum at the Output of a Nonlinear Four-Terminal Network

A. Ya. Yashkin, Computing the Natural Frequencies of Resonators with a Complex Shape in Terms of Cylindrical Functions

V. V. Malanov and *K. P. Polov,* Power Operation of a Pulse Amplifier for Audio-Frequency

I. A. Fastovskiy, Operation of a Passive Detector in Response to Pulses With Complex Shapes

G. G. Men'shikov, Design of Stable Transistor Trigger Circuits

A. V. Prosin, I. P. Igoshev and *I. P. Levshin,* Automatic Processing of Statistical Properties of Radio Signals by Means of an Electronic Computer

K. A. Reznik, Measurement of Percentage Modulation of Low Signal Levels

G. T. Shitikov, Stable Automatic Regulator Operating Close to the Natural Frequency

Radio Engineering and Electronic Physics

No. 5, May 1961

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V. M. Lopukhin, Kinetic power theorem and its application of electron-beam devices (Review)

B. N. Mityashin, Noiseproof feature of two methods of pulse signal reception

G. V. Druzhinin, Load of electronic circuit elements

A. I. Kalinin, Long-distance tropospheric ultra-short waves propagation and influence of the Earth

V. V. Novikov and *G. I. Makarov,* Pulse signal propagation over a plane homogeneous surface

Yu. L. Koburin, A. N. Sukhanovskiy, and *Yu. I. Alekseyev,* Investigation of a large-scale model of ionospheric inhomogeneities by a radioastronomical method

G. N. Krylov, Electromagnetic field of directional antennas over flat ground with finite conductivity

A. Ya. Yashkin, A method of calculating straight and bent waveguides of a complex cross-section in systems permitting separation of variables

L. N. Loshakov, Coupling impedance in a microwave device with transverse interaction

A. K. Musin, Plasma movement in intersecting electrical and magnetic fields

M. D. Karasev, Influence of parasitic parameters of a semiconductor diode on the operation of a parametric amplifier

A. L. Mikaelian and *A. A. Vasil'yev,* Interaction of magnetostatic oscillations in a ferrite sample during regeneration. Part II. Excitation of oscillations in a general case

N. G. Basov, V. V. Nikitin and *A. N. Orayevskiy,* Investigation of the dependence of master frequency upon different parameters. Part I (Theory, line J = 3, K = 2)

G. A. Syulina and *G. A. Feshchenko,* Fe^{3+} spin levels in corundum

Brief Reports

F. I. Khaytun, Increasing the transmission range of pulse signals with given energy during noise with arbitrary spectrum

B. A. Dubinskiy, Ideal method of measuring oscillation parameters

V. A. Sukhov, Characteristic impedance and attenuation of TEM-wave propagating along a multiplex line consisting of rectangular conductors

M. B. Tseytlin and *Ye. M. Il'ina,* Field in BWT with distributed attenuation

A. A. Shur and *G. S. Maximov,* A method of measuring radiowave phase fluctuations in the study of long-distance tropospheric propagation

Ye. M. Gershenzon, N. G. Ptytsina, G. I. Rozhkova and *V. S. Etkin,* Single-circuit parametric amplifier

A. N. Vakhrameyev, Experimental investigation of forced oscillations in parametrically regenerated oscillating circuit

Ye. M. Gershenzon and *V. S. Etkin,* Spectral and amplitude-frequency characteristics of superregenerative and parametric amplifiers

Yu. Ye. D'Yakov, Transfer function of superregenerative parametric amplifier

Yu. Ye. D'Yakov, A permissible error in the study of a two-circuit parametric amplifier

Yu. A. Kravtsov, Combination frequencies in systems with periodically varying reactance

G. N. Berestovskiy, Influence of asymmetry upon the operation of push-pull semiconductor converters with external excitation

N. V. Karlov, Yu. P. Pimenov, and *A. M. Prokhorov,* Paramagnetic 10 cm-band amplifier using Fe^{3+} ions in corundum

A. L. Mikaelian, A. A. Vasil'yev, and *V. V. D'Yachenko,* Microwave regeneration in ferrite through longitudinal pumping

V. G. Veselago, Spin oscillator

Chronicle

G. V. Spivak, V. N. Vertsner, V. M. Luk'yanovich, Ye. Ye. Levin, and *Yu. A. Skakov,* The 3rd All-Union meeting on electron microscopy

K. A. Akopov, N. A. Karelina, V. I. Pokalyakin, and *G. V. Stepanov,* Inter-institutional seminar on cathode electronics (17th meeting)

Telecommunications

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Ya. Z. Tsypkin, Analysis of Open-Loop Systems with Pulse-Amplitude Modulation

N. L. Teplov, Noise Proofness in Integral Reception of Signals under the Influence of Fluctuating and Sinusoidal Noise

Yu. A. Yerukhimovich, Calculation of Non-Linear Distortion in Waveguide Transmission Lines

N. S. Stanulov, A Simple Electronic Instrument for Statistical Research in the Field of Radio Wave Propagation

A. F. Beletskiy, Synthesis of Filters with Linear Phase Characteristics

V. Z. Nayderov and *Yu. L. Simonov,* Structural Stability of a Linear Four-Terminal Network

S. L. Kunina, A Quartz Master Oscillator Using Transistors

I. M. Zhdanov, On the Formation of Telephone Districts Under Conditions of Unequal Density

A. D. Ruga and *Ye. V. Kostyanets,* Transmission Parameters and Effects of Type TG Cables in a Frequency Range to 600 KC

As additional translated Tables of Contents become available prior to distribution of the translated journals, they will be listed in the Russian Translation Section Section of *Electrical Engineering.*

Lamme Medal Nominations Must Be Received by November

Members of the Institute again are reminded that they have an opportunity to submit nominations for the 1961 Lamme Medal. Nomination forms may be procured from Mrs. A. L. Landres, Secretary of the Lamme Medal Committee, at AIEE Headquarters, 345 East 47th St., New York 17, N. Y. Nominations are due at Headquarters not later than November 1, 1961.

Details regarding qualifications for the award were published in the April 1961 issue of *Electrical Engineering*, p. 290.

John Fritz Medalist Selected by Board of Award

The John Fritz Medal Board of Award has unanimously selected C. H. Greenewalt of E. I. du Pont de Nemours and Company, Inc., Wilmington, Del., to receive the John Fritz Medal and Certificate for 1962.

The citation states that the medal was awarded "for outstanding contributions to the American free enterprise system through leadership in research, in the translation of research achievements by way of sound engineering into useful products, and through [Mr. Greenewalt's] able championship of that system both in the spoken and written word."

Participating societies of the John Fritz Medal Board of Award and their representatives are: AIEE—W. J. Barrett, L. F. Hickernell, and J. H. Foote; American Society of Civil Engineers—L. R. Howson, F. S. Friel, and F. A. Marston; American Institute of Mining, Metallurgical and Petroleum Engineers—A. B. Kinzel, H. C. Pyle, and J. L. Gillson; American Society of Mechanical Engineers—J. N. Landis, G. B. Warren, W. L. Cisler; and American Institute of Chemical Engineers—G. E. Holbrook, D. L. Katz, and Jerry McAfee. Mr. Kinzel is the chairman of the Board of Award. The medal will be presented to Mr. Greenewalt by the American Institute of Chemical Engineers.

Technical Papers Requested for Point Computer Conference

A call for papers has been made by the Technical Program Committee of the 1962 Spring Joint Computer Conference in San Francisco, Calif., next May.

Authors interested in submitting papers are requested to furnish three copies of a complete first draft by November 10, 1961. No advance summary or abstract is required. Indications as to figures may be rough sketches.

Submissions should be made to the chairman of the Technical Program, as follows: Dr. R. I. Tanaka, Lockheed Missiles and Space Company, 3251 Hanover St., Palo Alto, Calif.

Recipient for 1961 Named for National Electronics Award

D. C. McDonald, engineering vice-president of Sola Electric Company, a division of Basic Products Corporation, has been named recipient of the National Electronics Award of Merit.

The presentation will take place at the 17th Annual National Electronics Conference (NEC) and Exhibition at Chicago International Amphitheatre, October 9-11, and carries with it a $750 award.

Mr. McDonald was selected on the basis of his paper, "Nonlinear Techniques for Improving Servo Performance," previously presented at the 1960 NEC. In accordance with the NEC's highly selective procedure, Mr. McDonald's paper is only the second to earn the award in the association's 17-year history.

In announcing the Award, Prof. M. E. Valkenburg, of the department of electrical engineering, University of Illinois, who is NEC chairman, stated:

"The committee regards this paper as the departure from conventional theory which opened the field of time-optional control. We regard it as a landmark in the development of automatic control in this country, and so deserving of the award."

The paper discusses methods of improving the ability of a servo or automatic control to follow rapidly varying motion. Though no exact mathematical solutions to this problem are known, the paper presented graphic means for analyzing high-speed operation of such devices.

Co-sponsors of NEC include: AIEE, Institute of Radio Engineers, Electronic Industries Association, and Society of Motion Picture and Television Engineers.

General Chairman Named for Telemetering Conference

H. W. Royce, manager of command and control advanced design in the electronics division of the Martin Company, has been elected general chairman of the 1962 National Telemetering Conference, to be held in Washington, D.C., next May.

The telemetering conference is jointly sponsored by AIEE, American Rocket Society, Institute of the Aerospace Sciences, Institute of Radio Engineers (IRE), and Instrument Society of America (ISA). More than 700 engineers and scientists from all parts of the United States and nine foreign countries attended the 1961 conference.

Mr. Royce announced that through the co-operation of ISA, two major conferences are holding meetings in the same week; the ISA symposium May 21-23, and the Space Electronic and Telemetering Conference May 23-25. This was done to help relieve the strain on national attendance at any one meeting when too many scattered meetings take place; also the latter is costly to the industrial concerns who foot the bills.

Last year, Mr Royce was chairman of the technical papers committee for the National Symposium on Space Electronics and Telemetry. During 1957-59, he was a member of the administrative committee of the IRE Professional Group on Telemetry and Remote Control, and has served, in 1957, as registration chairman of the first National Symposium on Telemetry, sponsored by this IRE professional group.

IRE and IAS Admitted to ECPD as Participating Bodies

The Institute of Radio Engineers (IRE) and the Institute of the Aerospace Sciences (IAS) have been unanimously elected participating bodies in the Engineers' Council for Professional Development (ECPD).

Representatives appointed by IRE are Pres. Ernst Weber, Polytechnic Institute of Brooklyn; Dean Gordon Brown, Massachusetts Institute of Technology; and Prof. T. F. Jones, Jr., Purdue University. President Weber has been appointed to serve on the Executive Committee.

IAS has selected as representatives William Littlewood, vice-president of American Airlines, Inc.; Chancellor C. C. Furnas, University of Buffalo, and Prof. J. W. Hoover, University of Florida. Mr. Littlewood has been requested to serve as Executive Committee member.

IRE was organized in 1912 "to advance the theory and progress of radio and allied branches of engineering and its related arts and sciences and to maintain professional standing among its members." It has 89,567 members.

IAS was founded in 1932 and its purpose is "to facilitate by all available means the interchange of technical ideas among aerospace engineers throughout the world." It has 15,905 members.

Other participating bodies in ECPD are: AIEE, American Society of Civil Engineers, American Institute of Chemical Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, American Society of Mechanical Engineers, Engineering Institute of Canada, American Society for Engineering Education, and National Council of State Boards of Engineering Examiners.

New Subsection Formed Within North Carolina Section

Formation of the North Piedmont Subsection of AIEE has been announced by N. S. Hibshman, Executive Secretary of the Institute.

The new Subsection, part of the North Carolina Section, includes the Counties of Alamance, Guilford, Randolph, and Rockingham. Subsection officers are R. O. St. Clair, Greensboro, N. C., chairman, and T. B. Sanders, Greensboro, secretary-treasurer.

The North Carolina Section is part of the South East District of AIEE, which also includes the States of Virginia, South Carolina, Georgia, and Florida.

Prior to formation of the North Piedmont Subsection, the North Carolina Section had no subdivisions.

Papers Solicited on Electronic Components

The 12th annual Electronic Components Conference, scheduled for May 8-10, 1962, at the Marriott Twin Bridges Motor Hotel, Washington 1, D. C., is soliciting papers on the subjects of electronic components and materials. Sponsors of the conference are AIEE, the Electronic Industries Association, and the Institute of Radio Engineers, with the American Society for Quality Control and the Society for Nondestructive Testing participating.

The meeting will be devoted to new developments in components, component-processing techniques, component evaluation, and component materials. The following topics suggest the scope of interest:

- Classical components: R, L, C, linear and nonlinear, lumped and distributed
- Combined function devices: integrated thin film circuits, multiple semiconductor devices, miniature modules
- Solid-state applications: ferroelectric, ferromagnetic, thermoelectric, magneto optic, electroluminescent
- Magnetics: square loop components, memory devices, magnetic films, magnetostrictive devices
- Electromechanical devices and concepts: switching devices, filters, delay lines
- Microwave components
- Filters and networks
- Connecting devices and techniques
- Processing, assembly and measuring techniques
- Nondestructive testing
- Component reliability
- Electronic materials
- Component-systems planning and integration

A 500-word summary, together with the author's name and address, should be sent to: H. A. Stone, chairman, Technical Program Committee, Bell Telephone Laboratories, Murray Hill, N. J.

The deadline for summaries is October 9. Authors will be notified of acceptance by November 20. To ensure prompt handling, 15 copies are requested. Final papers will be due on January 15 and will be published in the *Proceedings* of the conference.

Electric Utility Problems in Mid- and Far-East Described

P. K. Jones of Miner and Miner Company, Consulting Engineers, Inc., of Greeley, Colo., presented a program entitled "Electric Utility Engineering Problems Related to Middle-Eastern and Far-Eastern Areas of the World" at a recent meeting of the Denver Section, AIEE.

Mr. Jones, who is an Executive Committee member of the Denver Section, was accompanied in the presentation by engineers of Miner and Miner.

Using color pictures, the engineers described their activities and experiences in electrifying 10,000 villages in West Pakistan, which involved the design of 700 miles of transmission and several thousand miles of distribution lines.

One of the big problems, at the outset, was the setting up of design criteria and material and equipment standards. Customs such as the requirement of a steel cable "basket" beneath all high-voltage wires increased line costs. Introducing wood pole lines, where heretofore most electric lines were on lattice steel poles, tended to reduce costs. Much substation equipment, such as transformers, is mounted on wheels for mobility. In some of the villages, a trouble crew is comprised of two native Pakistanians pushing a cart with a bamboo ladder.

Engineering Foundation Re-Elects Chairman A. M. Gaudin

Engineering Foundation, research department of United Engineering Trustees, Inc. (UET), has announced the re-election as chairman of Prof. A. M. Gaudin of Massachusetts Institute of Technology.

Three new directors have been elected: Dr. H. L. Dryden, deputy administrator, National Aeronautics and Space Administration; Member-at-Large, Dr. L. F. Hickernell, of Hastings, N. Y., vice-president—engineering, Anaconda Wire and Cable Company; and Member-at-Large, R. A. Kinckiner, of Wilmington, Del., deputy director, Engineering Research Laboratory, Engineering Department, E. I. du-Pont de Nemours & Company, representing the American Institute of Chemical Engineers.

UET consists of AIEE, American Society of Civil Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Society of Mechanical Engineers, and American Institute of Chemical Engineers.

UET is owner and operator of the new United Engineering Center, at United Nations Plaza, the 20-story building which will house 18 professional engineering organizations and will be the largest assembly of engineering organization headquarters in the world. Through UET, its constituent societies engage in many cooperative projects and in the giving of major awards.

JECMB Seeks Invitations for Future Conference Locations

The Joint Executive Committee on Medicine and Biology (JECMB) is soliciting invitations for future conference locations.

An offer has been received from the Baltimore, Md., Professional Group on Bio-Medical Electronics (PGBME) Section of the Institute of Radio Engineers to hold the 1963 conference in that city. Other bids for the 1963 conference location will be considered if received before November 1, 1961.

Communications should be addressed to Dr. R. L. Bowman, chairman, JECMB, National Heart Institute of National Institutes of Health, Bethesda 14, Md.

Achievements and Goals of Soviet Engineering Reviewed

Recent achievements and future goals of the Soviet Union (USSR) in the field of engineering and engineering education and manpower utilization are presented in a report published by Engineers Joint Council, Inc. (EJC). For instance, the USSR annually graduates approximately 117,000 engineers, compared to 38,000 for the United States, and the Soviet plans call for substantial increases in that number.

The report, entitled "The Training, Placement and Utilization of Engineers and Technicians in the Soviet Union," is based on a tour of the Soviet Union made last year by six representatives of United States engineers sponsored by EJC with financial support of the National Science Foundation and under an exchange agreement between the United States and the USSR. The 112-page printed document, including footnotes, statistical data, and photographs, is available in limited numbers for $1.00 each from Engineers Joint Council, 345 East 47th Street, New York 17, N. Y.

Throughout the report there are indications of the impression made upon the delegation by the serious determination and zeal with which the people of the USSR approach technical education.

The education section, written by H. R. Beatty, president of Wentworth Institute in Boston, Mass., describes the high degree of specialization required of engineers and technicians, and defines the different types of engineering and engineering related institutions.

Dr. Oleg Hoeffding, an economist with the RAND Corporation, and a specialist on Russian economic affairs, gives a penetrating description of the framework of the master operating plan under which the training, distribution, and utilization of Soviet engineers and technicians takes place.

The enthusiasm with which technically employed persons in the USSR approach evening and correspondence study is discussed by Dr. S. B. Ingram (M '38, F '51), who spent many years as director of education and training for Bell Telephone Laboratories.

C. S. Dargusch, an attorney and former deputy director of the United States Selective Service, gives revealing observations on the motivation underlying the strong educational desires of the Russians.

The "Socialist Agreement on Co-operation," providing that professors shall work at enterprises with no additional pay, and also providing for use of engineering institute research facilities by plant research men and plant facilities by professors, is included in the observations by W. E. Lobo, a consulting chemical engineer.

Soviet practices on utilization are covered by comments made by R. M. Mahoney, an engineer currently engaged in personnel policy development for Union Carbide Corporation.

A brief concluding section outlines the delegation's views of the implications for the United States presented by the Soviet emphasis on engineering and engineering education.

AIEE FELLOWS ELECTED

Board of Directors Meeting, June 23, 1961

E. Dale Barcus (AM '29, M '43), toll service transmission engineer, Pacific Telephone and Telegraph Company, Los Angeles, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for contributions in the field of noise, crosstalk, and electrical protection and in the design of special communication transmission facilities." Mr. Barcus was born on October 17, 1902, in Terre Haute, Ind. In 1924, he received a B.S. degree in electrical engineering from the California Institute of Technology. Starting with Pacific Telephone and Telegraph as a student engineer graduate, he transferred to the chief engineer's department of Pacific Telephone in 1927, and worked in the protection engineer's organization on noise and crosstalk prevention, electrical protection, and foreign wire relations. In 1949, he became protection engineer, and in 1954, toll service transmission engineer in charge of groups handling engineering of television, private line and data, mobile radio, and new development transmission designs. Mr. Barcus is a member of the National Association of Corrosion Engineers, Pacific Coast Electrical Association, Los Angeles Electric Club, and a senior member of the Institute of Radio Engineers. He has served as District Secretary (1959-61) and on the following AIEE Committees: Wire Communication Systems (1950-53), Broadcasting (1954-61), and Radio Communication Systems (1959-61).

Earl Clayton Barnes (AM '41, M '48), chief engineer of the research, development, and engineering department, Reliance Electric and Engineering Company, Cleveland, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and engineering development of electric motors." Mr. Barnes was born May 20, 1918, in Ravenna, Ohio. He was educated at Ohio University, and at Case Institute of Technology from which he received the B.S. (1940) and M.S. (1949) degrees, both in electrical engineering. He joined Reliance in 1940 as a design and specification engineer in rotating a-c and d-c machinery. During the following 17 years, he was appointed, in succession, to the positions of a-c development engineer, senior electrical design engineer for Reliance's small and medium size a-c and d-c motors, manager of small motor engineering, and assistant chief engineer. In 1957, he was promoted to chief engineer of the research, development, and engineering department. In this assignment, Mr. Barnes is responsible for the direction, co-ordination, and planning of the corporation's engineering, research, design, and development activities for electric drives, systems, and machinery. He is a member of the Cleveland Engineering Society, the Cleveland Society of Professional Engineers, and Tau Beta Pi. Mr. Barnes has served on the AIEE Rotating Machinery Committee (1955-61).

Orlando E. Esval (AM '37, M '47), vice-president and manager, Motor Products Division, Wright Machinery Company, Division of Sperry Rand Corporation, Durham, N. C., has been transferred to the grade of Fellow in the AIEE ". . . for contributions in the field of aircraft flight instrumentation." Mr. Esval was born December 15, 1904, in Renville County, N. Dak. He received a B.S. degree in electrical engineering from Iowa State College in 1929. Mr. Esval entered the General Electric Company's Test Course in 1929 and was subsequently made proposition engineer, Single Phase Motor Engineering. In 1931, he joined Sperry Gyroscope Company where he worked first as a fire control engineer on armament projects, and then was assigned to experimental work on gyroscopics and rotor balancing in the Research Laboratory. In 1940, he became research engineer, assigned to flight, navigation instruments, and aircraft automatic controls. He was made research director in 1942 and was responsible for the development of nontumbling gyro horizons, the Gyrosyn Compass, and automatic pilots for Aircraft, which helped to advance all-weather flying techniques. In 1954, he became vice-president and chief of the Wright Machinery Company, Division of Sperry Rand, responsible for the engineering of automation devices and precision rotating components, and in 1959, vice-president and manager of the Motor Products Division of Wright. He is a member of the Institute of Aerospace Sciences and the Air Force Association.

Kugler's Inc.

W. K. Harding

William Knowlton Harding (AM '39, M '50), transmission engineer, Duke Power Company, Charlotte, N. C., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and construction of transmission lines and substations." Mr. Harding was born February 1, 1901, in Greenville, N. C. In 1923, he received the B.S. degree in electrical engineering from the University of North Carolina. After graduation, he joined Duke and was assigned to the electrical maintenance and construction department. In 1925, he became an electrical draftsman in the transmission engineering department, and subsequently was appointed senior electrical engineer. He was promoted to substation engineer in 1952 with supervision over all substation engineering, which included standardization of 220-kv substations. In 1959, he became transmission engineer, directly responsible for all electrical engineering involved in the design and installation of high-voltage transmission lines and substations, which includes the delivery of power to large consumers and the company's distribution system. A registered professional engineer in the State of North Carolina, Mr. Harding is a member of the Charlotte Engineers Club and has served on the AIEE Substations Committee (1954-61).

David Goodale Howard (AM '17, M '47, Member for Life), professor emeritus, U. S. Naval Academy, Annapolis, Md., has been transferred to the grade of Fellow in the AIEE ". . . for his contribution to the education in electrical engineering of the midshipmen of the U. S. Naval Academy." Mr. Howard was born May 10, 1890, in Townsend, Mass., and was educated at the Worcester Polytechnic Institute, from which in 1913 he received the

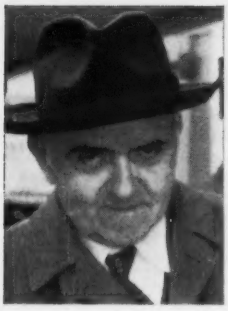
E. D. Barcus

E. C. Barnes

Churchill

O. E. Esval

D. G. Howard



George Keinath

C. L. Killgore

J. M. Kopper

Fabian Bachrach

H. R. Kurth

B.S. degree in electrical engineering, and in 1941 the Electrical Engineering degree. He was engaged in co-operative post-graduate research for Westinghouse Electric Company in 1913-14, and was employed by the Westinghouse research department in East Pittsburgh, Pa., in 1914 for oscillograph and high-voltage testing of varied types of electrical equipment. During 1916-17, he was an instructor of electrical engineering at the Carnegie Institute of Technology. In 1917, he entered the U. S. Naval Reserve and subsequently became a detailed instructor of electrical engineering. Transferred to civilian status in 1919, he served continuously as professor emeritus in the department of electrical engineering until his retirement in 1955. A registered professional engineer in the State of Maryland, Mr. Howard is a member of the American Society for Engineering Education, the American Association for the Advancement of Science, and Sigma Xi.

George Keinath (M '37), consulting engineer, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to instrumentation for measurement and in recording of physical quantities by electrical means." Dr. Keinath was born 1885 in Augsburg, Germany. He graduated from the Technical College of Munich in Germany in 1909 as doctor of engineering. For one year, he worked for the AEG in Berlin, Germany. During 1910-37, Dr. Keinath was director of development and research of the Siemens and Halske Company, Berlin, Wernerwerk M. He originated many new designs of instruments and high voltage instrument transformers. In 1928, he was named honorary professor at the Technical College of Berlin-Charlottenburg. In 1931, Dr. Keinath started the *Archiv fuer Technisches Messen (ATM)*, a unique type of magazine which is still published and uses a special coding system for the articles to facilitate filing as a "living book." He has been associated with the International Electrotechnical Commission. Dr. Keinath is known for his unorthodox methods of solving problems. In 1937, he came to the United States and undertook consulting work for a number of companies. He considers his best work the development of the sweep balance multirecorder, a new way of potentiometric recording giving 100 to 500 measurements per second, not with a deflection or force but as a time interval or count, ready for computing devices without separate converters from analog to digital, and giving the results in separate frames. Dr. Keinath is consulting technical director of the Keinath Instrument Company.

Cecil Lloyd Killgore (AM '37, M '47), president, Engineering Consultants, Inc., Denver, Colo., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to investigation, planning, and design of hydroelectric systems." Mr. Killgore was born in Hollywood, Calif., on June 3, 1910. He received the B.S. degree in electrical engineering in 1932 from the California Institute of Technology. During 1932, he worked at the Hoover Power Plant, first as a construction helper, then with the U. S. Bureau of Reclamation as a designer of control circuits and as a field engineer. In 1940, he was assigned to the Shasta and Keswick Power Plants of the Bureau and, in 1944, transferred to the chief engineer's office of the Bureau in Denver. In 1954, he was appointed assistant chief designing engineer responsible for engineering and administrative supervision of the electrical, mechanical, and hydraulic branches of the Bureau office in Denver. Three years later, he resigned from the Bureau and organized Engineering Consultants, Inc. Since its inception, the firm has been responsible for the planning and design of hydroelectric projects in Thailand, Pakistan, Ceylon, and Greece. Mr. Killgore is a member of the American Society of Mechanical Engineers, International Conference on Large Electric High-Tension Systems, National Society of Professional Engineers, U. S. Committee on Large Dams, and Consulting Engineers Association. He has served on the AIEE Switchgear Committee (1948-60) and System Engineering Committee (1949-51).

John Matthias Kopper (AM '34, M '43), supervisor of engineering research, Johns Hopkins University Radiation Laboratory, Baltimore, Md., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the solution of problems of electromagnetic warfare." Dr. Kopper was born September 15, 1912, in New York, N. Y. He received the bachelor's and doctor's degrees in electrical engineering from Johns Hopkins University in 1933 and 1944, respectively. He joined the electrical engineering department of Johns Hopkins in 1937 as a research assistant, became an instructor and, in 1944, an assistant professor. During 1944-46, while on leave of absence from the university, Dr. Kopper was a member of the central station engineering section of Westinghouse Electric Corporation, East Pittsburgh, Pa. He resumed teaching at Johns Hopkins in 1946, and organized the courses and laboratory in control systems. In 1952, he became research contract director in the university's Institute for Co-operative Research. In 1954, Dr. Kopper joined the Radiation Laboratory, where he has been working on problems in electromagnetic warfare. Dr. Kopper is a registered professional engineer in the State of Maryland, a member of Sigma Xi and Eta Kappa Nu, a Fellow of the American Association for the Advancement of Science, and a member of the American Physical Society, Electrochemical Society, Society for Industrial and Applied Mathematics, Tensor Club of Great Britain, and Research Association for Applied Geometry in Japan. He is a member of the AIEE Feedback Control Systems Committee (1956-62) and the Basic Sciences Committee (1959-62). He was chairman of the Maryland Section, AIEE (1960-61).

Henry R. Kurth (M '38), vice-president and director of steam and electrical operations, Boston Edison Company, Boston, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to power system operating practices and safety standards." Mr. Kurth was born April 26, 1900, in Cambridge, Mass. He received the B.S. degree in electrical engineering in 1921 from Massachusetts Institute of Technology. He was a research engineer at the Elihu Thomson Research Laboratory of the General Electric Company in 1921; that year, he joined the Standardizing and Testing Laboratory of Boston Edison Company. In 1924, he was transferred to the production department for the establishment of the new System Despatching Headquarters, the development of automatic frequency control equipment, and preparation of increment cost data and procedures for power interchange with other utilities. In 1943, he was advanced to chief of electrical operations, and in 1952, to assistant vice-president and superintendent of production and system operating departments. He was appointed to his present position in 1956. During 1921-46, he lectured on electrical engineering for the Division of University Extension, Department of Education, Commonwealth of Massachusetts. He is affiliated with the System Operators of New England, the Edison Electric Insti-

tute, and is a registered professional engineer in the State of Massachusetts.

Otto Naef (AM '23, M '31), consultant to the American Electric Power Service Corporation, New York, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions in the fields of arc extinction and insulation co-ordination which contributed to successful design of high voltage power systems, especially for extra high voltage circuit breakers." Mr. Naef was born April 22, 1892, in Winterthur, Switzerland. He received his diploma as electrical engineer in 1918 from the Swiss Federal Institute of Technology in Zurich. He was employed by the Swiss Brown Boveri Company and its British affiliate on transient phenomena and metal clad mercury arc rectifiers. In 1923, he joined the Scintilla Magneto Corporation, New York, later merged into the American Brown Boveri Electric Corporation, where he was chief engineer of application, service, and testing divisions and also in charge of circuit breaker design. Mr. Naef returned to Switzerland in 1932 and became manager of the switchgear and protective apparatus design department of the Oerlikon Engineering Company in Zurich. In 1948, he returned to the United States as circuit breaker engineer and later staff engineer of the American Gas and Electric Service Corporation, New York. Since 1960, he has been a consultant for switchgear to the American Electric Power Service Corporation. He is a member of the Swiss Electrotechnical Society and of the International Conference on Large Electric Systems. He served on the AIEE Automatic Stations Committee (1927-30) and Switchgear (1948-50).

Joseph S. Quill (AM '43, M '49), manager of marketing, Electronic Components Division, General Electric Company, Schenectady, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to application of gas turbines and associated electrical equipment to gas pipe line pumping." Mr. Quill was born in Peterboro, N. H., on December 22, 1918. He received the B.S. and M.S. degrees in electrical engineering from Massachusetts Institute of Technology in 1942. That year, he was assigned to research and development work at General Electric. After completing the company's Advanced Engineering Program, he was made responsible in 1947 for their electrical system application engineering work on the additions to the Hanford, Washington, and Oakridge, Tenn., atomic energy plants. Mr. Quill was a leader in the original conception and application of industrial gas turbines to gas pipeline pumping, and received General Electric's Coffin Award in recognition of his outstanding contribution in this area. In 1955, he was assigned to the company's Engineering Services operation, and in 1957, he became manager of product planning and marketing research of the industry control department. Since 1960, Mr. Quill has been responsible for the marketing work in the Advanced Product Planning Operation in the Electronic Components Division. He is a member of the Institute of Radio Engineers and the National Society of Professional Engineers.

Harold Vernon Rathbun (AM '29, M '37), vice-president, Western Light and Telephone Company, Inc., Great Bend, Kans., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and development of transmission and distribution systems in Central Kansas." Mr. Rathbun was born March 27, 1905, in Ottawa, Kans. He graduated from Kansas State University in 1927 with a B.S. degree in electrical engineering. After 18 months on a General Electric Test Course at Schenectady, N.Y., he joined the Kansas City Power and Light Company where he was assigned to the design of substations, street lighting, distribution, and transmission. In 1937, he joined the Copper Wire Engineering Association and was associated with Copperweld Steel Company in sales promotion work. During World War II, he served in the U. S. Army Signal Corps with the Plant Agency in Philadelphia, Pa., and in the China-Burma-India Theater as commanding officer of the 3361 Signal Service Battalion. A member of the Honorary Reserve as a retired lieutenant colonel, he joined Western Light and Telephone Company, Inc., as an engineer in 1947. He was made vice-president of transmission and distribution in 1959. Mr. Rathbun is a member of the National Society of Professional Engineers and is currently a director in the Kansas Engineering Society.

Joseph W. Rittenhouse (AM '40, M '48), technical director, Hi-Voltage Equipment Division, Joslyn Manufacturing and Supply Company, Cleveland, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to engineering education and to vacuum switching techniques." Mr. Rittenhouse was born January 22, 1917, in Neosho, Mo. He received the B.S. and M.S. degrees in electrical engineering from Purdue University in 1939 and from the Missouri University School of Mines and Metallurgy in 1949, respectively. In 1939, he joined the James R. Kearney Corporation in St. Louis, Mo., as an engineering assistant and later as an engineer. During World War II, Mr. Rittenhouse served in the U. S. Army Signal Corps, assigned to the Signal Corps Inspection Agency. Following military service, he joined the staff of the electrical engineering department of the University of Missouri School of Mines and Metallurgy. Mr. Rittenhouse joined the Roslyn Manufacturing and Supply Company in 1954 as technical director of the Hi-Voltage Equipment Company Division, the position he now holds. A registered professional engineer in the State of Missouri, he is a member of the National, Ohio, and Missouri Societies of Professional Engineers, and holds membership in the American Society for Engineering Education, the Cleveland Engineering Society, the Institute of Radio Engineers, and the Engineers Club of New York City. He belongs to Eta Kappa Nu, Sigma Xi, Tau Beta Pi, and Tau Kappa Alpha. Mr. Rittenhouse served on the following AIEE Committees: Student Branches (1953-58, chairman 1957-58), Education (1956-58), Administrative Department (1957-58), Admission and Advancement (1957-58), Publications Department (1957-58), Public Relations (1957-58), and Educational Publications (1959-60).

George Berthold Schleicher (AM '20, M '34, Member for Life), senior engineer, meter division, Philadelphia Electric Company, Philadelphia, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the development of transformer-loss compensation techniques for effecting economies in high tension metering." Mr. Schleicher was born in Hamburg, Germany, on November 26, 1896. He studied electrical engineering in Philadelphia, Pa., at the Drexel Institute of Technology. Mr. Schleicher started with Philadelphia Electric in 1917 as a tester. In 1925, he became technical assistant to the director, in the laboratories and testing section and, in 1929, technical assistant, in the meter division. His present position dates from 1952. Mr. Schleicher pioneered in the development of practical methods of metering high-voltage loads

Otto Naef

J. S. Quill

Clay Ward

H. V. Rathbun

Harry A. Cole

J. W. Rittenhouse

G. B. Schleicher

G. B. Tebo

L. T. Williams

R. G. Yerk

from the low-voltage side of the power transformers. He is a registered professional engineer in the State of Pennsylvania and a member of the Pennsylvania Society of Professional Engineers and the Engineers' Club of Philadelphia. Mr. Schleicher served as secretary of the AIEE Sections Committee (1959-60).

Gordon Buchanan Tebo (AM '36, M '44), manager, Testing Laboratories of the Canadian Standards Association, Toronto, Ont., Canada, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to research and to developments relating to the safe use of electric power." Mr. Tebo was born July 23, 1906, in Ethelbert, Manitoba, Canada. He received a B.S. degree in 1929 from the University of Toronto. Mr. Tebo joined Ontario Hydro the same year, spent 2 years in the operations department, transferred to the laboratory in Toronto, held a number of key positions in Ontario Hydro's Research Division, and was appointed director of research in 1953. He also served briefly as director of employee relations and director of organization services for Ontario Hydro. In 1958, he became manager of the Testing Laboratories of the Canadian Standards Association. Mr. Tebo is a member of the Association of Professional Engineers of Ontario, the Standards Engineers Society, the Engineering Institute of Canada, and the Engineers Club of Toronto. He has served on the AIEE Research Committee (1954-58) and Standards Committee (1956-61).

Loyd Thomas Williams (AM '27, M '45), chief electrical engineer, Southwestern Electric Power Company, Shreveport, La., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and development of oil field electric supply systems." Mr. Williams was born in Flagstaff, Ariz., on January 22, 1901. After graduation from the Texas Agricultural and Mechanical College in 1925 with the B.S. degree in electrical engineering, he was employed as a distribution engineer by the Southwestern Gas and Electric Company which later became the Southwestern Electric Power Company. In 1930, he became a design engineer for the Dallas Power and Light Company, and was assigned to industrial substation design. He rejoined Southwestern Gas and Electric in 1931 in the East Texas Oil Field Division and subsequently became division engineer, design engineer in the General Office engineering department, acting chief engineer, assistant chief engineer and, in 1955, chief electrical engineer responsible for the engineering design and construction of transmission lines and substation and distribution construction standards. A registered professional engineer in the States of Texas and Louisiana, Mr. Williams is a member of the American Association for the Advancement of Science and the Institute of Radio Engineers. He served on the AIEE Transmission and Distribution Committee (1943-48).

Ralph G. Yerk (M '49), chief engineer, Hughes Brothers, Inc., Seward, Nebr., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to design of wood transmission, distribution, and substation structures." Mr. Yerk was born in Chicago, Ill., on February 6, 1906. He has been associated with Hughes Brothers since 1927 and was made chief engineer in 1935. In addition to supervising the engineering work of the company, Mr. Yerk is in charge of research, development, and structure testing. He assisted in the design of the wood structures for the Public Service Company of Colorado's 500-kv high-altitude test line at Leadville, Colo., and contributed to the design of Pennsylvania Electric Company's 460-kv test line near Saxton, Pa., and the 345-kv test line of the Illinois Power Company. He is a collective member of the International Conference on Large Electric High Tension Systems and a member of the Nebraska Engineering Society.

AIEE PERSONALITIES

D. G. Blodgett (AM '55), formerly supervising field engineer, has been appointed assistant to the superintendent of Electrical System Performance for the Detroit Edison Company, Detroit, Mich.

Merwin Brandon (AM '28, F '44), president, Underwriters Laboratories, Inc., Chicago, Ill., received a gavel and plaque on May 17 from members of the Correlating Committee (both past and present) of the National Electrical Code Committee for his outstanding leadership as chairman of this committee. The presentation took place at the annual meeting of the National Fire Protection Association in Detroit, Mich. This committee is responsible for the preparation of the National

MEMBERS of the Correlating Committee (both past and present) of the National Electrical Code Committee presented this gavel and plaque to "Money" Brandon for his outstanding leadership as chairman of this committee

Electrical Code. Mr. Brandon served as chairman of this committee during 1951-61, until he relinquished the chairmanship to **H. B. Whitaker** (AM '37, M '51), vice-president and chief electrical engineer of Underwriters' Laboratories. Mr. Brandon served on the AIEE Safety Committee (1944-61) and Standards Committee (1944-61, chairman 1952-54). Mr. Whitaker has served on the AIEE Safety Committee (1951-61, chairman 1955-57).

B. M. Brenner (AM '56) has been appointed manager of the newly formed Advanced Development Department of Ampex Instrumentation Products Company, Redwood City, Calif. Mr. Brenner, who has a 3-year association with Ampex, has been assigned the direction of a series of studies in areas of special technical interest to the company and the development of ideas and techniques for advanced system design.

R. D. Chiff (M '59), formerly an engineering executive at International Telephone and Telegraph Corporation, heads the new firm of Rodney D. Chiff and Associates, consulting engineers, Bloomfield, N. J.

T. H. Cline (AM '41, M '49) has been appointed manager of engineering of Stevens Manufacturing Company, Inc., Mansfield, Ohio. Mr. Cline came to Stevens from the Newark-Ohio Company, a subsidiary of Sears, Roebuck and Company, where he was employed for 17 years, the last 12 as chief engineer of the Electric Range Division. He has served on the AIEE Domestic and Commercial Applications Committee (1949-61, chairman 1951-53) and Safety Committee (1953-61).

A. B. Credle (AM '35, M '43), manager, Advanced Technical Development, International Business Machines Corporation, Ossining, N. Y., was elected vice-chairman, Industrial Electronics Division, Electronic Industries Association at the association's 37th annual convention in May in Chicago, Ill.

M. W. Cresap, Jr. (AFFIL '59), president, Westinghouse Electric Corporation, Pittsburgh, Pa., has been elected a trustee of the Committee for Economic Development, Washington, D. C.

A. N. Curtiss (M '57) has been appointed to head the administrative and business activities of the central research organization of the Radio Corporation of America (RCA) in the newly created position of manager, administration, RCA Laboratories, at the David Sarnoff Research Center in Princeton, N. J. Mr. Curtiss was formerly general manager the West Coast Missile and Surface Radar Division, RCA Defense Electronic Products. He has served on the AIEE Fortescue Fellowship Committee (1957-63).

R. E. Deal (AM '49) has been elected vice-president—sales of the James R. Kearney Corporation, St. Louis, Mo. Mr. Deal joined Kearney in 1960 as sales manager.

P. M. DeRusso (AM '54), assistant professor of electrical engineering at Rensselaer Polytechnic Institute, has been promoted to associate professor. Dr. DeRusso, a Rensselaer graduate, joined the Rensselaer faculty as assistant professor in 1959.

F. W. Godsey, Jr. (AM '30, F '45) has become vice-chairman of the Board of Directors, Electronic Communications Inc. As a member of the Executive Committee, he will give particular attention to the Research Division in Baltimore, Md., and to the Advanced Technology Corporation, wholly owned research subsidiary in Santa Barbara, Calif. Mr. Godsey was formerly president of Electronic Communications, a position he held since 1956.

J. A. Haddad (AM '46), previously general manager of the company's Advanced Systems Development Division, has been promoted to vice-president and assistant general manager of the Data Systems Division of International Business Machines Corporation in New York.

J. R. Harkness (AM '37) has been appointed to the newly created position of vice-president—marketing for Librascope Division, General Precision, Inc., Glendale, Calif. He was formerly manager—electronics for the Bendix-Pacific Division.

J. B. Harris, Jr. (AM '17, M '45, Member for Life), formerly president of Rumsey Electric Company, Philadelphia, Pa., has been elected board chairman and chief executive officer. **C. L. Greenley** (AM '51), formerly vice-president, was elected president of the company. **W. T. Johns, Jr.** (AM '44) was named vice-president and chairman of the Executive Committee. **H. J. Sheppard** (AM '34, M '51) has been named vice-president of sales and manager, utility and power department, and director. Mr. Sheppard has served on the AIEE Board of Directors (1960-61).

M. S. Hartley (M '56) has been appointed manager of the Cleveland, Ohio, engineering division of Brush Instruments, a unit of Clevite Corporation. Mr. Hartley comes to Brush from Polaroid Corporation.

M. E. Haskins, Jr. (AM '50) has been appointed to the newly created position of manager, management science, in the Electric Data Processing Division of the Radio Corporation of America. Mr. Haskins joined the corporation in 1959.

A. D. Hasley (M '57) of Bell Telephone Laboratories represented the AIEE at the International Measurement Conference held in Budapest, Hungary, on June 25-July 4.

R. J. Heh (AM '49) has been appointed manager of the Utility Products Division of the Thomas and Betts Company, Elizabeth, N. J. Mr. Heh served as assistant manager of the division since 1957.

Elected directors of the Aircraft Electrical Society, Los Angeles, Calif., to serve 2-year terms on the Executive Committee, are: **Charles Hennigan** (AFFIL '55), Norair Division of Northrop Corporation, and **M. O. Jack** (AM '49), Douglas Aircraft.

G. H. Herrick (AM '26, M '33), formerly vice-president and general manager of the Electrical Division, Fairbanks, Morse & Co., headquartered at Freeport, Ill., will head up divisional headquarters sales of large electrical machinery at Beloit, Wis.

R. E. Horn (AM '52) has been named manager, Allis-Chalmers Manufacturing Company's regulator department, Milwaukee, Wis. He was appointed acting manager of the department 6 months ago. Mr. Horn has served on the AIEE Aero-Space Instrumentation Committee (1957-61). **A. H. Baguhn** (AM '56), formerly senior development engineer in the regulator department, has been named chief engineer.

R. L. Hostetler (AM '53), consulting engineer in Akron, Ohio, in the fields of industrial controls and instrumentation, has joined Goodyear Aircraft Corporation's engineering organization. He has been assigned responsibilities of an engineering specialist in the firm's systems and computer engineering group.

R. L. Houlton (AM '47) has been appointed manager—process automation engineering by the General Electric industry control department, Salem, Va. He formerly headed the department's Advanced Automation Control Project.

J. C. Hoyt (M '45) of Woodcliff Lake, N. J., has been elected 1961-62 chairman of the New York Section, AIEE. Mr. Hoyt is an engineer with Gilbert Associates, Reading, Pa., and New York City. Other elected officers are: **W. G. Cheney** (AM '48, M '58), Rye, N. Y., vice-chairman; **A. E. Joel** (AM '42, M '48), South Orange, N. J., secretary; **S. H. Grim** (AM '38, M '52), Rockville Center, N. Y., treasurer; and **A. B. Giordano** (AM '40, M '57), Brooklyn, N. Y., and **L. E. Gray** (AM '52), Staten Island, N Y., members at large. Mr. Joel served on the AIEE Communication Switching System Committee (1957-61).

A. H. Hurst (AM '56) has been appointed as application engineer in the sales department of Erie-Pacific, Division of Erie Resistor Corporation, Hawthorne, Calif. Mr. Hurst was transferred to the West Coast division from the parent company in Erie, Pa.

E. J. Isbister (AM '34, M '47) has been appointed vice-president—engineering of Radiation Inc., Melbourne, Fla. Mr. Isbister was formerly chief engineer of Sperry Gyroscope's Surface Armament Division, Long Island, N. Y.

S. J. Jatras (AM '47, M '56) has been named vice-president of Lockheed Electronics Company and general manager of its Avionics and Industrial Products Division located in Los Angeles, Calif. Mr. Jatras was formerly acting general manager of the Division.

T. F. Jones, Jr. (M '58), head of Purdue University's electrical engineering school, has been named a director of the board

of the Columbus Process Company, Inc., Columbus, Ind.

K. J. Joyce (AM '52) has been appointed supervisor of entertainment equipment sales—midwestern region for the Electronic Tube Division of Sylvania Electric Products Inc., a subsidiary of General Telephone & Electronics Corporation.

K. B. Karns (AM '50, M '61) has been appointed staff engineer for Establishment Electronic Engineering, Federal Aviation Agency, Kansas City, Mo. Mr. Karns was formerly chief of Navigation Aids Electronic Engineering. He has served on the AIEE Aerospace Transportation Committee (1959-61).

Raymond Kendall (AM '52) has been appointed manager of research and engineering programs at Information Technology Laboratories, a division of Itek Corporation, Lexington, Mass.

M. J. Knop (AM '56), former consulting engineer to leading electronic companies on the Minuteman program, has joined Microdot's Magnetics Division, in South Pasadena, Calif.

F. R. Lack (M '37, F '48) has been named to the newly created post of senior vice-president in charge of research of the Sprague Electric Company, North Adams, Mass. Mr. Lack has been a Sprague director since 1959.

W. E. Landauer (AM '48, M '55) has joined the G. C. Dewey Corporation, New York City, as senior associate in charge of its electronics laboratory. Prior to joining the corporation, Mr. Landauer was Airborne Instruments Laboratory, a division of Cutler-Hammer.

Edward Lavin (AFFIL '57) has been named director of applications research of Shawinigan Resins Corporation's research department in Springfield, Mass. He was a research section leader since 1955.

G. F. Law (AM '54) has been promoted from field application engineer to power apparatus manager by the I-T-E Circuit Breaker Company, Philadelphia, Pa. Mr. Law was transferred from Houston, Texas.

W. D. Lawrence, Jr. (AM '56) was on home leave during February and March in the United States from an assignment with the U. S. International Co-operation Administration (ICA) in Ceylon. Mr. Lawrence is one of a group of technicians who have been helping to develop plans for a multipurpose water utilization project in Colombo, Ceylon, for the Mahaweli River. He has spent the last 2 years assisting with a hydroelectric power generation plant for the project. Before leaving Ceylon, Mr. Lawrence organized a training course to teach Ceylonese linemen the techniques of working on energized electric lines. The course will be held in India in an ICA-assisted school. When Mr. Lawrence returns to Ceylon, he will conduct a series of power system studies to show how to plan transmission lines.

B. E. Lawton (AM '45) has been promoted to the post of eastern regional sales manager for the Electronic Tube Division, Allen B. Du Mont Laboratories, Divisions of Fairchild Camera and Instrument Corporation, Clifton, N. J. Mr. Lawton was formerly regonal manager for the south east.

A. H. Leader (AM '48) has been named vice-president—sales of the Sequoia Wire and Cable Company, a subsidiary of the Anaconda Wire and Cable Company, Redwood City, Calif. Mr. Leader has been Los Angeles district manager for Anaconda since 1960. In his new position, Mr. Leader will assume over-all responsibility for the Sequoia national sales program.

F. W. Lehan (AM '46) has been elected executive vice-president of Space Electronics Corporation. Since 1958, he was vice-president of the firm.

D. J. Love (AM '52, M '59) has been appointed to the new position of product manager for Advanced Control Systems, Control Corporation, Minneapolis, Minn. Mr. Love was formerly manager of industrial sales at the Pannellit Division of Information Systems, Inc.

H. T. Lowell, Jr. (AM '56) has been appointed general sales manager for the Baldwin - Lima - Hamilton Corporation Force Measurement Products Group, according to an announcement by the company's Electronic and Instrumentation Division in Waltham, Mass.

D. C. Luce (AM '36, F '49) was re-elected president of Public Service Electric and Gas Company, Newark, N. J., by the board of directors of the company.

R. W. MacKay (AM '54) has been named chief project engineer at the Bay City plant of the Electric Autolite Company, Toledo, Ohio. He was formerly chief engineer for generators.

Michel Mamon (AM '58), a specialist in magnetic amplifiers for instrumentation and automatic control, and a leading electronic designer of transistor circuitry, has been appointed vice-president in charge of engineering for Dynex Industries, Inc. Mr. Mamon was formerly with International Telephone and Telegraph Laboratories.

Devereaux Martin (M '43) has rejoined Estey Electronics, Inc., Torrance, Calif., to become general operations manager of the firm. Vice-president in charge of Estey's electronics and engineering when the firm was located in Brattleboro, Vt., Mr. Martin has most recently been project manager, Hughes Aircraft Company, Communications Division, in Los Angeles, Calif.

James Massara (AM '60) has been named application engineer, regulator department, Allis-Chalmers Manufacturing Company, Industries Group, Milwaukee, Wis.

F. J. McCluskey (AM '32, M '39) retired February 28 from the position of assistant chief engineer of the James R. Kearney Corporation of St. Louis, Mo.

M. B. McDavitt (M '40, F '51), director of transmission development of Bell Telephone Laboratories, New York, N. Y., has been elected a vice-president of the company. **A. C. Dickieson** (M '41, F '59) has been named director of transmission development. Mr. Dickieson was formerly director of transmission systems development.

Receives Ninth 'Outstanding' Rating

CHIEF of the electrical department at the U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va., (right) O. P. Cleaver (AM '36, M '48) recently received his ninth "Outstanding" rating certificate. Col. J. H. Kerkering, director, made the presentation. Mr. Cleaver holds more work performance awards than any other employee at the Laboratories and has also received several "Sustained Superior Performance" awards. He has been with the Laboratories in a military and civilian capacity since 1942

M. D. McFarlane (AM '27, F '51), research scientist with the Aeronautical and Instrument Division of the Robertshaw-Fulton Controls Company at Anaheim, Calif., has been appointed general chairman of the 1962 Winter Convention on Military Electronics.

L. E. Merrow (M '36), vice-president of Orange and Rockland Utilities, Inc., Nyack, N. Y., has been elected to the Board of Directors of the company.

F. M. Precopio (AM '56) has been named manager of engineering for the General Electric Company's Wire and Cable Department. Mr. Precopio was formerly manager of chemistry and insulation for the D-C Motor and Generator Department of General Electric's Erie plant.

W. S. Pritchett (AM '43, W '50) has joined Hallikainen Instruments, Berkeley, Calif., as chief electrical engineer in charge of all electronic and electrical aspects of instrument development and design. For the last 4 years, he was chief engineer of Knopp, Inc., Oakland, Calif.

C. E. Quick (AM '53, M '58) has been named stations and industrial power engineer for the Detroit Edison Company's general engineering department. He was formerly industrial power engineer. He has served on the AIEE Industrial and Commercial Power Systems Committee (1954-61).

A. H. Rector (AM '47, M '54) has been admitted as a partner to the firm membership of Burns & McDonnell Engineering Company, Kansas City, Mo. He joined Burns & McDonnell in 1947. Mr. Rector has served on the AIEE Transformers Committee (1959-61).

K. H. ReCorr (AM '59), an electrical engineer with the Tube Division of the Radio Corporation of America, Harrison, N. J., represented Rutgers University on May 17 in the annual awards made by the New York Chapter of the American Statistical Association to an "outstanding student in statistics." His award consisted of $50 and a membership in the American Statistical Association.

Joseph Reed (M '50) has been named executive engineer in the systems department of the Adler Electronics Military Products Division in New Rochelle, N. Y. He was formerly principal engineer at General Precision Laboratories.

R. G. Rincliffe (AM '42, M '57), president of the Philadelphia Electric Company, has received the 1961 award of the Philadelphia Public Relations Association for his promotional efforts on behalf of the City of Philadelphia, Pa. Mr. Rincliffe was honored for his company's national advertising program which promoted the Port of Philadelphia. He was also cited for his role in uniting utility companies throughout the country for development of peaceful uses of atomic power.

Hyman Rosen (M '59) has been appointed chief electronic engineer of the new Ground Support and Systems Engineering Division of Tenney Engineering, Inc., Union, N. J.

R. W. Ross (AM '54) has been appointed manager of the field service department of Minneapolis-Honeywell's Electronic Data Processing Division. In addition to his new responsibilities, he will continue as assistant director of the Division's operations engineering department. Mr. Ross was formerly assistant manager of the department.

L. M. Roth (AM '47) has been appointed assistant director in Union Carbide's Design and Construction. Formerly engineering group leader, he will continue to maintain offices at Carbide's Technical Center in South Charleston, W. Va.

J. B. Rudden (AM '50) has been appointed to the Automobile Traffic Control Section of Ramo-Wooldridge, a Division of Thompson Ramo-Wooldridge Inc., Los Angeles Calif. Mr. Rudden will be the resident Ramo-Wooldridge engineer in Chicago, Ill., for the Congress Street Expressway study project.

D. J. Santogrossi (AM '45) has been appointed chief engineer of Vernitron Corporation, Torrance, Calif., and Carle Place, L. I., N. Y.

Gilles Sarault (M '46), consulting engineer of Quebec City, has been elected vice-president of the Corporation of Professional Engineers of Quebec in Canada.

M. W. Scheldorf (AM '38, M '45) has been appointed senior engineer in electronics research at Armour Research Foundation of the Illinois Institute of Technology. Mr. Scheldorf joined the Foundation in 1959 as a research engineer.

C. W. Schemm (AM '27, M '47), principal electrical engineer of Sverdrup and Parcel and Associates, Inc., engineers-architects, St. Louis, Mo., has been appointed by the Missouri Governor to serve on the Action Committee of the Governor's Traffic Safety Conference. Mr. Schemm is president of the Missouri Society of Professional Engineers.

W. R. Schofield (F '32), a vice-president and member of the Board of Directors, Leeds and Northrup Company, Philadelphia, Pa., retired May 31 after 45 years with the instrument and controls manufacturers. He commenced his career with the company as a draftsman in 1916, and held the positions of assistant chief engineer, chief engineer, and director of engineering, successively, before becoming a vice-president in 1944. He was elected to the Board of Directors in 1957.

W. R. Schofield

R. J. Shafranek (AM '47, M '54) has been named chief engineer in charge of the Electrical Power Equipment Section, Electrical Product Development, at Tapco, a division of Thompson Ramo Wooldridge Inc., Cleveland, Ohio. **A. F. Naylor** (AM '49) has moved from Electrical Product Development to Mechanical Product Development as assistant to the manager.

A. J. Sherburne (AM '54) retired in April after completing 40 years with General Electric. Mr. Sherburne has been responsible for several developments in the insulating area. He joined General Electric in 1920 and spent his first 8 years in the Research Laboratory where he worked on various chemical problems. In 1928, he concentrated on the insulating area, and in 1931 headed a group devoted to insulating materials development and application, especially resins, varnishes, and coatings. During 1948-55, he was manager of insulating products engineering. Mr. Sherburne has served on the AIEE Electrical Insulation Committee (1957-61).

D. C. Sherrick (M '56) has been appointed manager of technical liaison of STELMA, Inc., Stamford, Conn. Mr. Sherrick was formerly Washington technical director of the Kleinschmidt Division of Smith-Corona Marchant. He has served on the AIEE Telegraph Systems Committee (1958-61).

E. I. Shobert II (M '51), manager of research, Stackpole Carbon Company, has recently been elected a member of the Board of Directors for Susquehanna University, Selinsgrove, Pa.

L. M. Silva (AM '52) has been appointed chief engineer of Electrosolids Corporation, Los Angeles, Calif. Prior to joining Electrosolids, Mr. Silva was manager of the technical staff on research and development at Beckman Systems.

J. F. Smith (AM '49) has been named manager, utility sales and distribution planning of General Electric's re-aligned agency and distributor sales development operation, with headquarters in Schenectady, N. Y. **R. C. Hanna** (AM '39, M '52) has been named manager, distributor products sales development, of the new operation.

A. P. Stern (AM '55) has been appointed director of engineering in the Electronics Division of the Martin Company, Baltimore, Md. He comes to Baltimore from Syracuse, N. Y., where he was manager of the electronics applications laboratory of the General Electric Company. Mr. Stern has served on the AIEE Electronics Committee (1957-61) and Solid State Devices Committee (1959-61).

F. H. Streit (AM '30) has been elected vice-president, electrical operations, Co-

lumbus and Southern Ohio Electric Company, Columbus, Ohio. He had been manager, production department, since 1954.

M. R. Sullivan (M '42) of San Francisco, Calif., has been elected to the Board of Directors of Rheem Manufacturing Company of New York City. Mr. Sullivan was president of Pacific Telephone and chairman of the board until his retirement on February 25 under the company's 65-year retirement rule.

S. B. Swift (AM '52) has been promoted to associate managing engineer, Underwriters' Laboratories, Inc., Chicago, Ill., assigned to duties of Section head in charge of the Signaling Device Section at the New York office. He was formerly senior project engineer.

I. F. Thomson (AM '56) has been appointed manager of components assembly at Non-Linear Systems, Inc., Del Mar, Calif. Prior to joining Non-Linear Systems, Mr. Thomson was senior design group engineer at Convair-Astronautics.

R. C. Waldron (M '38) has been named chief engineer at the Okonite Company, Passaic, N. J., wire and cable fabricating subsidiary of Kennecott Copper Corporation. He succeeds **R. J. Wiseman** (AM '16, F '27, Member for Life), who retired on December 31, 1959, but who now serves as Okonite's cable consultant. Since 1955, Mr. Waldron served as manager of engineering in the Marketing Division. Dr. Wiseman served on the AIEE Edison Medal Committee (1956-61). **R. B. Blodgett** (AFFIL '56) has been appointed director of research of the Okonite Company. A member of Okonite's research staff since 1954, Dr. Blodgett has been concerned with research activities at Okonite's Paterson, N. J., plant, in the capacity of manager of paper cable research.

T. C. Ward (AM '51), former vice-president and chief engineer of Kinetics Corporation, Solana Beach, Calif., has been named executive vice-president and chief engineer. **W. A. Schmidt** (AM '52), former operations manager, has been promoted to vice-president.

L. E. Welch (AFFIL '60) has been appointed assistant engineer in the d-c machine design section of the electrical department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. He recently completed the Allis-Chalmers training course for graduate engineers.

H. J. Williams (AM '54) has been promoted to supervising field engineer for the Electrical System Equipment Division of Detroit Edison Company, Detroit, Mich. Mr. Williams was formerly supervising laboratory engineer.

S. W. Winje (AM '23, F '49, Member for Life), superintendent of substations for Indiana and Michigan Electric Company, Fort Wayne, Ind., was honored May 26 at a retirement party attended by 100 of the utility's officials from a 2-state area. A veteran of 38 years of service with this company and its predecessors, and more than four decades in electrical utility work, Mr. Winje retired on May 31. Mr. Winje is a former manager of electric operations for both the Indiana Service Corporation and the Fort Wayne Division of the company. He had been the superintendent of the company's 250 substations since 1955. During 1951-53, he was on leave to serve as "Co-ordinator of Power Supply, Indiana Area," in charge of directing the sale of energy from 10 utilities to the Tennessee Valley Authority serving Atomic Energy Commission load requirements.

A. A. Wolf (M '57) has joined the staff of the Emerson Research Laboratories Division of Emertron, Inc., as director of research. Dr. Wolf comes to the Laboratories from General Dynamics Electronics Corporation, where he was scientific advisor to the vice-president of research.

OBITUARIES

Thomas Alpin Dodson (AM '50, M '56), head electrical engineer, Lower Colorado River Authority, Austin, Tex., died June 14. Mr. Dodson was born November 21, 1904, in Yarrellton, Tex. He received a B.S. degree in electrical engineering in 1926 from the Agricultural and Mechanical College of Texas. He was associated with the Lower Colorado River Authority during the last 10 years. Prior to this, he was employed by the Fargo Engineering Company during the construction of Granite Shoals and Marble Falls dams on the Colorado River and West Texas Utilities in Abilene, Tex. He was a member of the Texas Society of Professional Engineers.

David Hall (AM '03, M '07, F '18, Member for Life), retired engineer of the Westinghouse Electric Corporation, died recently. Mr. Hall was born July 30, 1874, at Fayetteville, Tenn. He graduated in 1896 with the electrical engineering degree from Lehigh University. He joined Westinghouse in 1908 as a direct current designer at East Pittsburgh, Pa. In 1911, as section engineer in the Power Division, he was given charge of the large d-c machinery used in steel mills, electric railways, mines, and on submarines, and other Navy ships. From 1926 until retirement, he was manager of district engineering for Westinghouse in Southern California and Arizona. He was a member of Tau Beta Pi and a past chairman of the Los Angeles Section, AIEE. He served on the AIEE Electrical Machinery Committee (1921-24).

John Maxian, Jr. (M '43, F '57), section head (electrical) for North American Aviation, Inc., Los Angeles, Calif., died June 20, 1961. Mr. Maxian was born September 24, 1905, in Wheeling, W. Va. He studied electrical engineering at the Linsly Institute of Technology from which he graduated in 1928. He was associated with North American Aviation beginning in 1928, and 8 years later was made chief electrical engineer. A pioneer in aircraft

John Maxian, Jr.

electricity, Mr. Maxian directed the development of electrical pressurization control, electrical and fire control provisions, and the first jet engine electrical control system. He contributed to the evolvement of the first radar navigation system for fighter aircraft, the first radar fire control system, and the first supersonic speed fighter. Mr. Maxian served on the AIEE Aero Space Transportation Committee (1944-46, 1951-61).

Harry Finch Naramore (AM '48), apparatus engineer, Line Material Company, Cleveland, Ohio, died July 6. Mr. Naramore was born November 26, 1917, in Wichita, Kans. He received degrees of B.S. and M.S. in electrical engineering in 1938 and 1939, respectively. Mr. Naramore was associated with the Line Material Company from 1948.

Max Rubenstein (AM '27, M '48), consultant in the governmental agency sales department, of the Washington, D.C., offices of the Anaconda Wire and Cable Company, died on June 27. Mr. Rubenstein was born January 28, 1892, in Philadelphia, Pa. He joined Anaconda as district sales manager in Philadelphia, Pa., in 1931, when Cables Accessories Company, with which he was associated as vice-president and sales manager, merged with Anaconda. He became district sales manager in Washington in 1933. Twenty-four years later, Mr. Rubenstein was named manager of government agency sales. Upon his retirement in 1960, he continued actively with Anaconda as consultant.

Alan Griffith Stanford (M '28, F '50), vice-president of Robert and Company Associates, Atlanta, Ga., architects and engineers, died recently at the age of 67. Mr. Stanford was born June 12, 1894, in Charleston, S.C. He graduated in 1914 from Clemson, S.C., Agricultural and Mechanical College with a B.S. degree in electrical-mechanical engineering. He started with Robert and Company in 1919 as a junior electrical engineer. During 1942-44, he served as project general manager for the company on the design and construction of the Marietta, Ga., aircraft assembly plant for the production of B-29 bombers. Mr. Stanford was vice-president of the company beginning in 1945. He served as president of both the National Society of Professional Engineers and the National Council of State Boards of Engineering Examiners; and on the AIEE Transfers Committee during 1956-58.

OF CURRENT INTEREST

Man's Conquest of Space Depends Upon Varied Tools

Artist's conception of the 150-foot-diameter dish antenna for the Stanford radar telescope. It will be used for cosmic-distance measurements, surface explorations of the moon and planets, and for obtaining ionization data

In ever-widening areas of interest, scientists and engineers are putting much effort into solving the mysteries of space. Some of this effort has resulted in satellites presently orbiting the earth while other work is going into preparations for future space research. In the following paragraphs, a few selected projects are reviewed.

● Stanford University and Stanford Research Institute will begin new studies of the solar system later this year with a radar telescope reported to be America's largest. The parabolic reflector antenna for the telescope is as tall as a 15-story building. A 20-60 mc transmitter built by Continental Electronics Manufacturing Company for the system requires a million-watt power supply.

Operation of the radar telescope will be a joint project of the University's Radioscience Laboratory and the Institute's Communication and Propagation Laboratory—with support from the Air Force's Cambridge Research Laboratories. University and Institute scientists will share the new facility while conducting programs in basic and applied research.

Research findings anticipated by the group include: (1) more accurate measurements of cosmic distances: (2) surface explorations of the moon and planets; (3) new knowledge about the ionization density and distribution in the sun's outer corona and around various planets; and (4) data about the amounts and movements of ionized gases and space debris between the earth and the moon and in interplanetary space.

● Forces as minute as one millionth the pull of gravity can be measured with a highly accurate space guidance instrument developed by Sperry Gyroscope Company. In addition to detecting minute forces, the device can also measure forces as great as 30 times the pull of gravity.

Weighing slightly over 2 pounds, the new unit, an integrated accelerometer, can replace a trio of single-direction accelerometers that have a combined weight and space requirement three times that of the newly developed instrument.

This integrated accelerometer developed by Sperry Gyroscope Company is shown under test. The unit is designed to measure a wide range of forces acting on space vehicles

Key to the operation of most advanced inertial guidance systems, the accelerometer is responsible for precisely recording an unlimited range of velocity changes that may occur during flight. Should an acceleration force equivalent to one millionth the pull of gravity go undetected, a space vehicle could drift hundreds of miles off course.

● Signals picked up from the Navy's navigational satellite, Transit, are being transmitted by a radioisotope-fueled SNAP (Systems for Nuclear Auxiliary Power) thermoelectric generator designed and built for the U. S. Atomic Energy Commission by The Martin Company.

The generator uses a nonfissionable form of plutonium (Pu-238) as its fuel. Since Pu-238 has a half-life of 89.6 years (its radioactivity will drop by only 50% during that period), the new generator is theoretically capable of powering a space transmitter and instrumentation for an extremely long period of time.

Nuclear power plant is fastened to the base of the latest Transit satellite before vibration tests at Johns Hopkins' Applied Physics Laboratory

When the world's first astronauts land on the moon, they will live in a plastic-lined balloon in a giant cave beneath the lunar surface, according to scientists of The Franklin Institute. Rocket shells will be sliced into cylinders and brought inside the balloon structure to house the space men and store supplies

The chief advantages of radioisotope-fueled generators for space use are their small size, light weight, long life, and reliability. Unlike solar cells, the operation of SNAP generators does not depend on exposure to the sun. Even a rechargeable storage battery system can be eliminated. The atomic power source is also far less delicate than solar cells.

● Prototype of a "moon room" unveiled by The Franklin Institute is a cylindrical shell 10 feet in diameter and 7 feet high. It would be made from a rocket that originally carried astronauts to the moon, sliced in sections. An inner coating of polyurethane plastic would be used for strength and sound-proofing.

On the moon, according to The Franklin Institute, the astronaut will encounter extremely hazardous conditions. Meteorites will crash to the lunar surface at speeds up to 45 miles a second. Temperature under a high sun will approach the boiling point of water but if the spaceman steps into the shadow of an overhanging ledge, temperature will drop several hundred degrees. Also, gamma rays, X rays and ultraviolet radiation will come from the sun, possibly with solar flares, that would boost radiation by a factor of 100,000.

Tiros III television infrared satellite mounted for spin tests at RCA in Princeton, N. J. One of weights used to slow down spin is shown being adjusted

The logical place to begin living on the moon, says The Franklin Institute, will be beneath the lunar surface, perhaps in a cave. An inflated balloon sprayed with a setting plastic will be the ideal covering shelter for the colony inside the cave. The first astronauts will literally make an eggshell of the balloon to retain an atmosphere similar to that of the earth. The pressure of the atmosphere will be about 7 psi.

Within the balloon will be built the moon-room quarters for the individual astronaut. The balloon will probably house a number of these rooms.

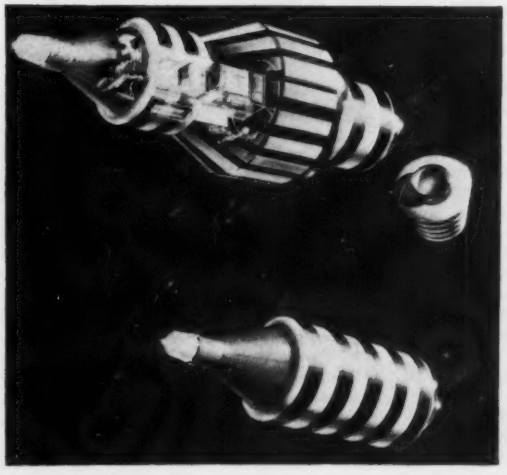
● Tiros III, the nation's newest weather satellite, was built for the National Aeronautics and Space Administration by the Radio Corporation of America. The new satellite carries two wide-angle television cameras as well as a new experimental infrared sensing system developed at the University of Wisconsin.

Purpose of Tiros III is to observe weather patterns and changes around the world and, particularly, to report on the origin and development of hurricanes in the Atlantic and Caribbean areas.

Each of the two cameras will photograph cloud patterns over an area of about 700 miles on a side for transmission to the ground stations.

The infrared equipment consists of an omnidirectional sensor system carried on outriggers extending from opposite sides of the satellite's circular base. The sensors will determine the thermal radiation characteristics of the earth by measuring the heat radiated toward earth by the sun and the amount that is reradiated from the earth's surface and atmosphere. Other infrared equipment also aboard the satellite is used to measure heat variation on the earth's surface and in the atmosphere.

Transistorized circuits are used in the



Artist's rendering of expandable space structures proposed by Aeronutronic Division of Ford Motor Company. Structure in orbit (top) has been expanded to provide laboratory area for space experimentation

electronic "clocks" which trigger the operation of the television cameras and other equipment at any desired point in orbit. The new circuits replace an arrangement of moving parts used in the earlier Tiros clocks.

● The best laboratory for testing the design and materials for spacecraft is space itself. This is the view of scientists at Ford Motor Company's Aeronutronic Division who are conducting studies of semirigid and nonrigid manned space structures for extreme-altitude Air Force weapon systems. The work is being done under a contract awarded by the Aeronautical Systems Division of the U. S. Air Force System Command, Wright-Patterson Air Force Base.

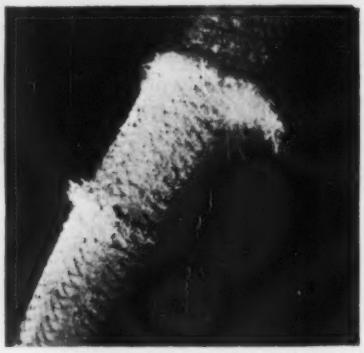
The Aeronutronic scientists are studying various modular concepts for space structures. A typical spacecraft might consist of a command post or cab up front—a highly secure, rigid structure capable of re-entry. In the center would be a propulsion component containing power for orbital correction or abort and having a retro-thrust rocket for de-orbit and re-entry. In back would be a living shelter or laboratory structure packaged within a van module for deployment once in space.

Three general structure concepts are being studied. These are pressure-stabilized membrane structures, rigid-panel inflatable structures or "space shingles," and telescoping modules.

Use of the membrane structures will depend on how well multilayer plastics or rubberized materials can meet conditions encountered in space. The space shingle concept involves use of panels—curved or flat, interlocking or overlapping—which can supplement flimsy membrane structures and provide necessary armor within a variety of configurations. The telescoping module could be either rigid or semirigid and would be attached to the space cab directly or by a flexible connection.

When deployed, telescoped modules would be strung out behind the cab and could be used as inflated storage compartment or instrumented packages or as transmitting balloons such as Echo.

● Molybdenum trioxide, a split-personality vapor with Jekyll-Hyde characteristics, has the frustrating faculty of short-circuiting electric systems in 1,500-degree temperatures and then insulating them to cover the cause when room temperature is resumed. Boeing Co., contractor for Dyna-Soar, discovered the phenomenon during simulated space flights of the Air Force maneuverable manned space craft.



Close-up of molybdenum trioxide whiskers which have taken root in a piece of standard aircraft wiring insulation shows what could happen to unprotected electric systems after experiencing the temperatures of re-entry

Molybdenum, a popular space-craft material because of its resistance to searing temperatures, oxidizes if exposed to air at high temperatures. Engineers surmount this problem by coating the molybdenum with a protective material. Tiny holes and hairline cracks which occasionally develop in the coating are not big enough to affect the structure of the craft seriously, but they do expose minute areas of molybdenum. Even small quantities of molybdenum trioxide evaporating from these minute areas penetrate aircraft wiring and short-circuit electric signals. At temperatures below 500 F, the molybdenum trioxide crystalizes and forms tiny "whiskers" which act like insulation, thereby correcting the trouble.

Because of the whisker formation, the electric system would appear normal if checked on the ground. But if the craft were flown again without determining the cause and location of the short circuit, the whiskers would vaporize and the problem would start all over.

Present plans to protect the electric system against this phenomenon are to encase the wire in solid metal sheaths with the sheath only slightly larger than the wire itself. A mile of the sheathed wire weighs only about 40 pounds.

When completed, the Dyna-Soar space craft will be boosted into space by a modified Titan intercontinental ballistic missile. On his return from space, the pilot will be able to maneuver his delta-winged glider in the atmosphere like an airplane and make a conventional landing at an airfield of his choice.

RACEP—Discrete Address System Makes Possible Clear Voice Transmissions

RACEP, which stands for "Random Access and Correlation for Extended Performance," is the equivalent of a private radiotelephone system having the operating characteristics of an ordinary telephone system without the use of wires or central switchboards. A subscriber can "dial" any other subscriber and talk privately with no interference. The system is a product of the Martin Company's Orlando Division, which gives the following description:

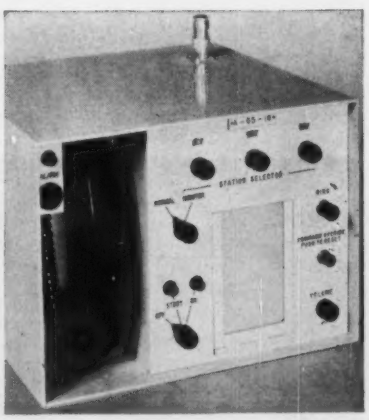
Civilian and military fields of communications in a position to profit from the RACEP development include: (1) Pilot-to-ground-controller communications in both civilian and military air traffic control. (2) Communications for commercial firms and municipal departments (fire, police) between controller or dispatcher and fleet vehicles. (3) Communications in emergency disaster situations. (4) Private, commercial, or military ship-to-shore communications. (5) Private telephone-type world-wide communications via orbital satellite relay.

Equipment models demonstrate that RACEP can handle 700 subscribers, each person having full use of his equipment at all times. Range of the prototype models is about 15 miles, with additional range possible.

The increasingly crowded radio spectrum can at times be hazardous to life and property. Radio voice communications between pilots, both civilian and military, and air traffic control centers sometimes become incomprehensible gibberish because of multiple interference between many transmitting stations trying to reach the same receiving center. Similarly affected are mobile police and fire department radio communications systems. The RACEP system uses this crowded spectrum with utmost efficiency.

Because of RACEP's unique ability to use a single channel for multiple 2-way communications without interference, a large number of stations can operate at the same time with clear voice transmission and reception. Previously, only one station could accomplish this on a single channel in the same area. Martin engineers say that RACEP's ultraefficient use of frequency bands should help to free certain portions of the radio spectrum of their present clutter.

Essentially, the system adapts a new modulation technique to carry voices in the form of quick pulses of radio energy



New communications system RACEP's self-contained transmitter, receiver, power amplifier, and antenna. Claims to be first industry breakthrough in field of wide-band communications systems. Revolutionary new development uses wide-band pulse system resulting in improved voice transmission; will handle several hundred subscribers. Maximum ground range exceeds 10 miles

on a single frequency band simultaneously between many persons and locations. It puts to use the pauses and breaks in normal conversation as well as the idle time between calls, by disintegrating and coding speech signals into millionth-of-a-second fragments, combining them at random, and transmitting them all at once over the same channel. Only receivers preset for the proper code of a specific conversation can receive it and reconstruct its fragments into a normal flow of speech. The coded circuits of transmitters can be varied manually to match those of particular receivers.

The system is likened to a huge bin into which colored glass marbles are flung at random for rapid transport through a pipeline so narrow that it can admit only one marble at a time. Hundreds of tie lines along its length are as narrow, but have traps that will pass a single color and no other. The marbles are pulverized in the bin and mixed together. As the colored glass dust flows through the main line, in the analogy, the tie lines capture the properly colored particles and reconstruct them into individual marbles.

Military Application

A good measure of military security is claimed as inherent in the RACEP system. Full cryptographic security may be adapted to it because of its digital characteristics. In connection with tactical warfare, Martin scientists ask us to consider a battle in which six squadrons of the Tactical Air Command of the Air Force are requested to support three Army ground divisions. On the 30-square-mile battlefield are hundreds of communications networks containing thousands of radio transmitters and receivers.

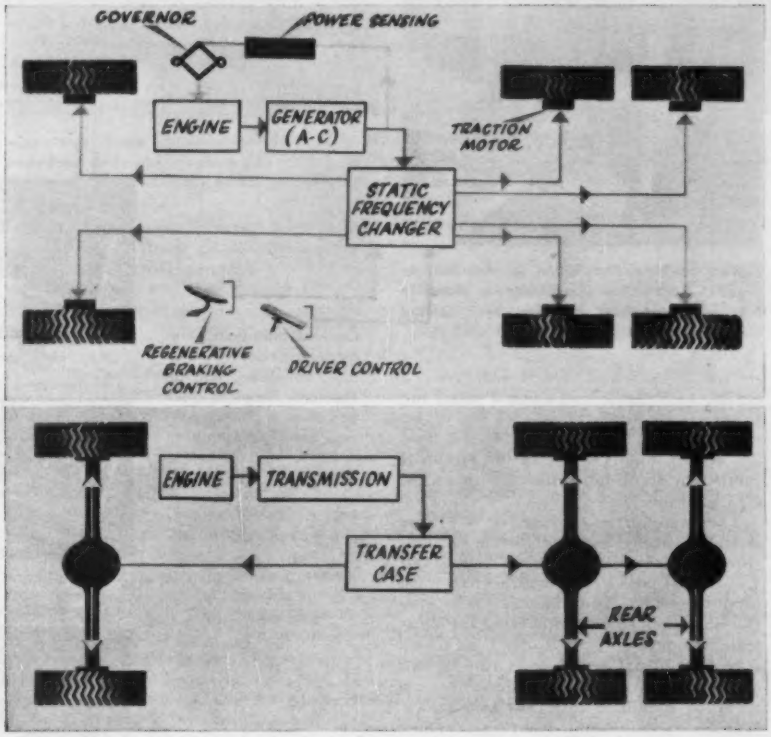
Artillery, infantry, and support groups, as well as aircraft crews and commanders, are talking among themselves and with their command posts. Simultaneously, there are radio communications between ground and air. Other forms of radiation in the battle zone—radar and radio-control systems for guided missiles—add to the violent hodgepodge of interfering signals. Such confusion, that could lead to defeat, would be eliminated by RACEP, through which clear, unhampered communication is achievable with the ease of turning a knob and picking up a telephone.

Because of the random-access feature of RACEP, no central communications center could fail and paralyze total communication. Each unit is self-contained, and can reach any other unit from any location merely by having its transmitter set to the receiving code of another unit.

Callers need not wait until the channel is clear before making a call. Scores on the same frequency can use a particular band at the same time because of the random access technique. RACEP's "command over-ride" permits all receivers within range to accept an emergency call from the single transmitter originating the call, whether or not the individual receivers are in use at the time.

Several other operational advantages are claimed for RACEP, among them, interference-rejection, instant availability, conference-call capability, commander-monitoring of every set without tuning, and portability or mobility.

A-C Electric Drive System Powers Huge Army Truck



Proposed a-c electric transmission system (above) has many important advantages over conventional mechanical transmission system (below)

Weight of a 2½-ton truck will be reduced by as much as 1,800 pounds when a new a-c electric drive system is installed. The new system, developed by the Jack and Heintz Division of Siegler Corporation, will be installed in an *M-34* vehicle under a prototype contract awarded to the firm by the Army Ordnance Tank-Automotive Command.

With the new system, conventional mechanical power transfer parts such as transfer cases, transmissions, and clutches are eliminated. Instead, locomotion of the vehicle is accomplished with induction traction motors built integrally into each wheel. The motors are operated by alternating current produced by an engine-powered generator. Current is fed to the individual motors through an electronic static frequency changer.

One major advantage of the system is a reduction in weight because of the elimination of parts. The weight reduction can mean an increase in the payload of a 2½-ton vehicle by as much as 40%. A second major advantage is that the a-c transmission system can become a mobile electric power plant capable of serving other functions in addition to propulsion. In this way, a military vehicle could be self-contained for operation of such devices as missile transporters, erectors, and launchers.

Additional advantages of the system for military vehicles include improved reliability, simplified maintenance, increased operating economy and better ground clearance.

The system is adaptable for special-purpose land and amphibious vehicles, either wheeled or tracked.

Pigeons Carry Transmitters for Tracking Experiments

Extensive research in the method by which a pigeon is enabled to home-in on its roost is being expedited through use of miniature transistorized transmitters attached to the pigeons. It is believed that a thorough understanding of the principles involved in pigeons' flights will enable scientists and engineers to develop improved navigational systems for civilian and military use.

The tracking system involved was developed for the Office of Naval Research by American Electronic Laboratories, Inc. The system includes a miniature transistorized transmitter which can be attached

Pigeon tracking transmitter is mounted on pigeon's back as shown. Package is probably the largest payload that has been carried successfully by a pigeon

to the pigeon and which will emit a readily identifiable radio signal when the pigeon is in flight. Weight of the entire transmitter including battery is less than 2½ ounces. Flight course of the pigeon is plotted by tracking stations set up at several locations.

The transmitter package is a 140-mc crystal-controlled oscillator driving a transistorized amplifier which delivers about 1 mw of r-f power to a modified half-wave dipole antenna. Four mercury cells give the unit a continuous operating life of at least 20 hours.

In some initial experiments, two pigeons equipped with the transmitters were released at 10-minute intervals from a location 25 miles distant from their home roost. Both were tracked to their roost. When the first one landed, it was still possible to receive the transmitted signal. Both birds completed the flight in about 25 minutes.

Sonic Boom Research Gets Under Way

With the projected development of 2,000-mph supersonic commercial airliners, the phenomenon of sonic boom has become a target for thorough investigation. A co-ordinated research program by the National Aeronautics and Space Administration, the United States Air Force, and the Federal Aviation Agency is scheduled for a 6-month program.

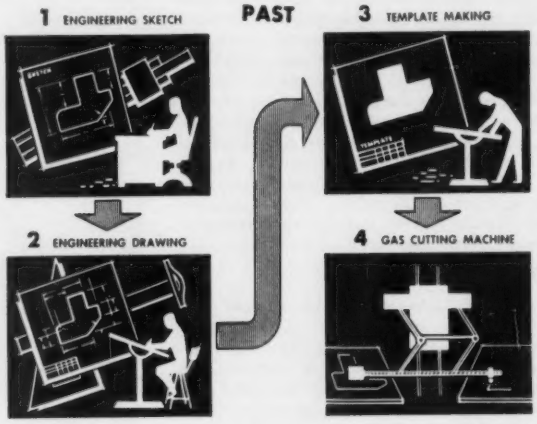
The research will be divided into four projects covering specific areas: sonic boom generation and progagation; design considerations to minimize sonic boom intensity; operational procedures to minimize sonic boom and its effects.

Sonic boom can be defined simply as an explosion-like sound caused by a shock wave generated by an aircraft flying at supersonic speed. It occurs when an aircraft moves through the air at a speed which exceeds sound and generates pressure waves. The waves attain the shape of a large cone extending downward and rearward from the plane in all directions.

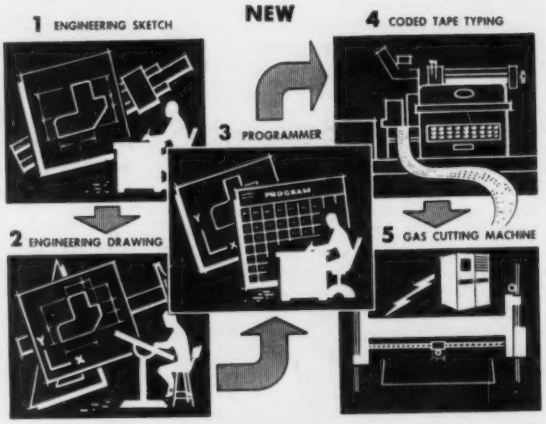
Numerically Controlled Flame Cutter Lowers Cutting Costs

Especially suited for use in shipyards and by large and medium-sized fabricators, a new flame-cutting machine is said to be the first such device numerically controlled by tape. The new machine eliminates the need for templates, template tables, and reliance upon an operator to control the flame-cutting process. The system was developed by Air Reduction Sales Company in co-operation with General Electric Company.

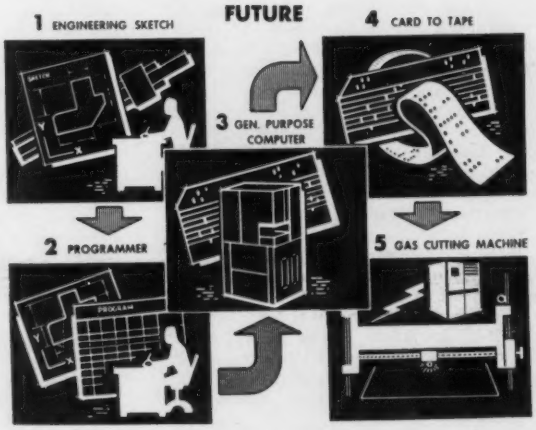
Consisting of a General Electric Mark



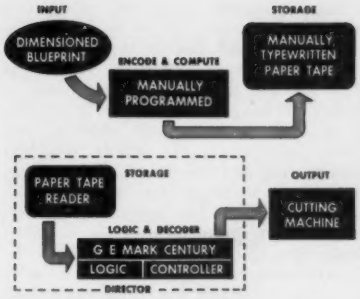
Conventional system requires engineering drawings, templates, and an electronic tracer to drive and steer a pantograph-type cutting machine



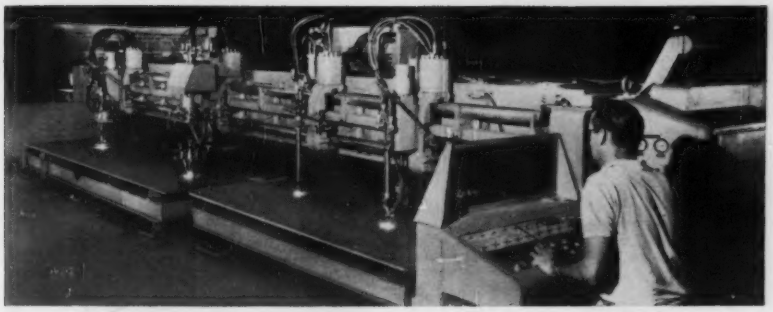
New system requires engineering drawing from which a program is prepared manually including other auxiliary functions. Program is transferred to paper tape which is used as input to the cutting machine



Future system adds a general-purpose computer to program complex parts without engineering drawings



Numerically controlled cutting system consists of two main components—the director and the cutting machine proper



Four-torch flame cutter is shown slicing through steel plate automatically while operator watches. Prototype machine has cutting width of over 20 feet and will handle lengths up to 40 feet with an accuracy of within 1/64 inch of true position

Century numerical contour control system and the cutting machine proper, the system provides fully automatic control of flame-cutting operations by means of predetermined, numerically coded instructions. Lowest cutting costs should be obtained because of optimum automation of all operations.

With the system, the part to be cut is designed, and engineering drawings are prepared. A program is devised by extracting dimensional information from the drawings. The information is then transferred to paper tape by an automatic punch typewriter. The system is also compatible with the use of electronic computers for simplified programming.

The punched tape provides the input data to the cutting machine. After initial positioning by an operator, all operations are fully automatic. Auxiliary functions such as starting and stopping the machine, igniting of preheat flames, flame control, gas supply control, and cut sequence are programmed on the tape. Cutting speeds, also controlled by the tape, can be programmed within the limits of 2 to 35 inches per minute. The system is equipped with four cutting torches and has an accuracy of $\pm 1/64$ inch.

The machine has a cutting width slightly in excess of 20 feet. It will cut two 10-foot or narrower plates side by side. Cutting length can be made to order, but with the cable and hose lengths installed on the prototype machine, the available length is about 40 feet.

Each side of the machine is driven by a separate gear-head motor connected by a servo-tie system to prevent skewing and maintain the proper precision. Extending across the front of the main bridge structure joining the two side sections of the machine is a drive screw driven by a motor on the operator's side of the machine. This screw drives the torch heads and positions the cutting torches in the *Y* direction.

The prototype machine has a continuous drive screw, half of which is threaded left-hand and half right-hand. This feature permits cutting of two plates, one being the mirror image of the other.

In preparing a cutting program, two basic types of information are placed on paper tape. The numerical information required to determine the actual shape of the part to be cut is obtained from engineering drawings. The second type, auxiliary function information mentioned previously, is also included.

The machine is programmed from point to point and each following point represents a departure from each new starting point. Straight lines and arcs of circles can be programmed. The paper tape is a standard 8-channel tape as used in the machine tool industry for numerical control.

A future variation of the system might include a computer assist to program complex parts without the benefit of engineering drawings. In such a system, a general-purpose computer and its accessories, would use a simple engineering sketch with certain key dimensions as a starting point.

Construction of the numerical control is solid-state with components mounted on printed-circuit boards with simple plug-in connections. A test routine tape is provided to check for proper operation of the digital circuits. With this technique, a complete check takes only 5 minutes.

Under the joint development agreement between Air Reduction and General Electric, the latter company will provide factory-trained engineers to inspect the control and machine combination both before and after it is shipped to the user. Service contracts will be available for preventive maintenance and emergency service at nominal charge.

Water Bullets Penetrate Steel— Cause Light Emission

Drops of water traveling at velocities up to 3,400 mph can penetrate thin pieces of metal as would a rifle bullet, according to Westinghouse Electric Corporation research scientists. Purpose of the company's experiments is to study the action of water droplets upon the rapidly spinning blades of a steam turbine.

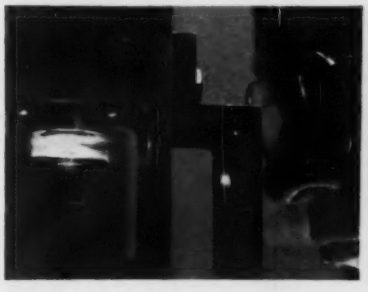
Over a long period, drops of water in moist steam erode the leading edge of a whirling turbine blade. Similar erosion occurs on the surfaces of airplanes and missiles when they collide with raindrops during high-speed flight in the rain.

Westinghouse experiments are designed to study the complex erosion process in its simplest form. Single drops of water, fired at metal surfaces under carefully controlled conditions, replace the countless drops moving about inside a turbine with unknown speeds and directions.

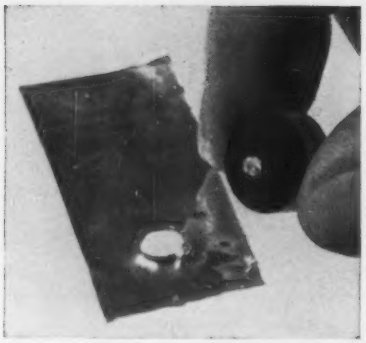
The water bullets are produced by compressed air. A small lead pellet is fired down a 30-inch metal tube by gas pressures of about 150 psi. The pellet strikes a small sealed reservoir of water having a tiny opening aimed in the direction of the metal sample. Upon impact, the lead pellet squeezes out a jet of water which crosses a 1-inch gap and strikes the metal's surface. The slug of water reaches the metal in about 15 millionths of a second. To study it en route and upon impact, a high-speed camera arrangement photographs it at intervals as short as 5 millionths of a second.

A peculiar light is emitted when the water strikes the metal and this also is recorded on the photographic film. The flash of light lasts for less than 1 millionth of a second. Why the light forms at the instant of impact of the water on the metal surface is not yet understood.

Of the metals tested, Stellite (a cobalt alloy) and tungsten carbide have shown the greatest resistance to the supersonic



Brilliant flash of light is generated by impact of a single supersonic drop of water shot like a bullet into solid steel at speeds up to 3,400 mph



Single drop of water easily penetrates thin pieces of aluminum and puts dent in a sample of solid steel when shot from a compressed air gun

water bombardment. Other facts uncovered by the experiments are: uniform jets with a smooth leading face cause more damage than irregularly shaped jets; irregularities in the metal surface have little effect on erosion damage; thin films of water or oil do not protect the surface of the metal and visible damage, barely seen on the metal surface, appears to correspond to the actual threshold of water erosion damage experienced in the operation of steam turbines.

Signal Corps Receives New Radio Communications System

Recently displayed by U.S. Army Signal Corps in a working demonstration at Fort Myer, Va., was a high-powered mobile radio communications system which would apply to one of the major problems in limited warfare. The new system is designed compactly, so that it can be flown, trucked, or floated anywhere, and can begin operation from its own power sources within 2 to 8 hours, for use in fast-moving special warfare Army units.

Communications will consist of from 1 to 3 telephone channels and 8 to 16 teletype channels, permitting spoken or printed messages instantly, in code if desired. Known technically as the *AN/TSC-18, 19,* and *20,* the three radio systems have ranges of transmission and reception of 7,500, 5,000 and 2,500 miles respectively. The greatest distance from the Pentagon of a high-powered permanent radio installation is 3,000 miles and these new global communications radio systems may be expected to fill a crucial need. The systems were designed and engineered by Adler Electronics, Inc., of New Rochelle, N.Y.

Adler's global radio units are furnished with single side-band equipment for long-range, multichannel communication. Each side band carries multiple information channels and greatly increased power facilities.

The 1-kw *TSC-20,* which is the lowest-powered but most compact of the three units, provides one telephone channel and eight teletype channels with a range of 2,500 miles. It can be carried by a single assault aircraft to the heart of a battle area, is self-contained and self-sustaining. The whole 1-kw unit consists of a small shelter plus two subscriber packages for remote operation. It can be completely set up in 2 hours, and ready to transmit and receive over a 2,500-mile range.

The 10-kw *TSC-19* provides 3 telephone channels and 16 teletype channels with a range of 5,000 miles. It is made up of four small shelters and power generators, is extremely compact, fully mobile by air, and capable of being set up at an Army headquarters or in disaster areas in 8 hours, at which time it is ready to transmit or receive over a 5,000-mile range.

A Signal Corpsman uses teletype equipment in the air-transportable shelter of one of the systems in the Army's new family of long-range, air-transportable communications systems. *AN/TSC-18* and 19 each provide three voice and 16 teletype channels, while the *AN/TSC-20* has one voice and three teletype channels. Where needed, one facsimile channel can replace 1-voice channel in each of the systems

More powerful than the other two models, the 40-kw *TSC-18* is nonetheless fully mobile and can be instantly transported by air to trouble spots. This 40-kw unit has the same channel provision as the *19;* its range is 7,000 miles. It consists of a trailer, three small shelters, and power generators; the whole powerful transmitting and receiving unit can begin dispatching messages after an 8-hour assembly period. Its special usefulness would be in supplementing or restoring badly damaged military radio facilities. Its extensive range would easily allow it to bypass a damaged link in an established communications system and to beam messages on to the nearest undamaged link.

From a subscriber station of the *AN/TSC-20,* a Signal Corps operator sends a teletype message to the TSC-20 terminal station which is tied in to the Army's globe-circling STARDOM network

Power Flows at Rocky Reach

Electric power has started flowing from the first of seven generators at the $262 million Rocky Reach hydroelectric project on the Columbia River near Wenatchee, Washington. All seven generators, capable of producing 775,000 kw, are expected to be operating by November 1. According to Stone & Webster Engineering Corporation of Boston, which designed and supervised construction of the project for Public Utility District No. 1. of Chelan County, Washington, there is space for four more generators. These would raise output eventually to 1,215,000 kw

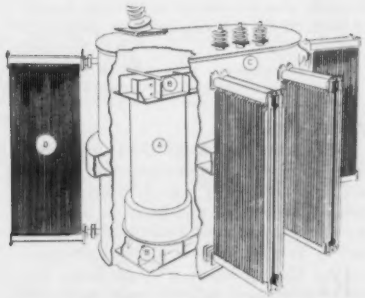
20,000–Kva Power Transformer Has All-Aluminum Parts

Fabricated for Aluminum Company of America by General Electric Company, a 20,000-kva power transformer is believed to be the largest ever built with all electrical and structural parts made of aluminum. The transformer has been installed in a substation at the Alcoa plant in Massena, N. Y., and is being used for voltage step-down from 115 kv to 13.8 kv and 6.9 kv.

Constructed of aluminum—except for the magnetic core, interconnecting cables and insulating parts—the 3-phase, Y-to-delta transformer employs an all-welded aluminum tank, aluminum core clamps, and aluminum radiators. Its winding structure incorporates aluminum foil in the high side and aluminum wire in the low side.

Better transient voltage characteristics obtained through the use of the aluminum foil instead of wire for high-voltage windings was cited by both companies as the chief electrical advantage of the new prototype transformer.

Mechanical advantages resulting from optimum use of aluminum in power transformers compared with conventional materials are: more efficient heat exchange; increased corrosion resistance; reduced maintenance costs, and potentially lower material and manufacturing costs.



Prototype aluminum power transformer has parts labeled A,B,C, and D made of aluminum. These parts are: A—windings; B—core clamp and coil supports; C—tank and D—radiators

"Watchdog Television" Security System Demonstrated

"Watchdog Television," a new electronic safety system specifically devised to combat apartment house crime, was demonstrated recently by Bell Television, Inc., designers, producers, and installers of television electronic equipment.

Developed by Martin Sugar, president of Bell, this method of home protection enables a tenant from his apartment to identify and check visitors visually at outside main and service building entrances before admitting them.

" 'Watchdog Television' is the tenant's personal 24-hour 'radar defense' against the growing menace of apartment house entries by unknown dangerous intruders," Mr. Sugar stated.

A visitor entering the main vestibule or service entrance of an apartment building equipped with the new system must step directly in front of a concealed television camera when looking at the customary panel of tenants' names and signal buzzers.

This continuously operating camera immediately transmits the visitor's image directly to a 5-inch television screen, conveniently prelocated in a wall of each apartment residence.

The tenant getting the buzzer signal presses a button which lights the screen, thus revealing a close-up of the downstairs caller. If he desires, the tenant can then press the customary release button unlocking the downstairs entrance door. A house telephone situated above the screen permits 2-way conversation.

In addition to its present introduction as an apartment house security safeguard, Mr. Sugar expects this closed-circuit television innovation to have a large number of other important business and industrial applications.

Concentrators Increase Efficiency Of Silicon Solar Cells

According to The Boeing Company, the amount of electricity which silicon solar cells produce from sunlight can be increased by about 45% through use of special sunlight concentrators.

Studies conducted on the slopes of Mt. Rainier have made use of a Somor concentrator adapted to solar cell use. The cells are mounted on the concentrator which is oriented to face the sun. Specially anodized aluminum surfaces of the concentrator are designed to reflect maximum additional sunlight to the cells.

Some of the equipment used in experiments to increase the efficiency of silicon solar cells

Importance of increased efficiency is apparent when the cost of silicon solar cells is known. For example, enough cells to light ten 100-watt bulbs costs about $350,000. Today's relatively small satellites require from 10 to 200 watts.

Studies conducted on Mt. Rainier with the concentrator have produced sunlight intensity of more than 100 watts a square foot. About 130 watts a square foot exist in space in the vicinity of the earth.

Future Meetings of Other Societies

16th National Conference, Association for Computing Machinery and 1st International Data Processing Exhibit, Sept. 5-8, Statler-Hilton Hotel, Los Angeles, Calif. B. F. Handy, Jr., General Chairman, Litton Systems, 5500 Canoga Ave., Woodland Hills, Calif.

International Symposium on the Transmission and Processing of Information, Sept. 6-8, Massachusetts Institute of Technology, Cambridge, Mass. E. M. Hofstetter, Asst. Prof. of Electrical Engineering, MIT, Research Lab. of Electronics, Cambridge 39, Mass.

ISA, 16th Annual Conference and Exhibit, Sept. 11-15, Biltmore Hotel, Los Angeles, Calif. E. J. Minnar, Technical & Educational Services, Instrument Society of America, 530 William Penn Place, Pittsburgh 19, Pa.

SPE, Regional Technical Conference, Sept. 12, Hotel Severin, Indianapolis, Ind. R. D. Forger, Society of Plastics Engineers, 65 Prospect St., Stamford, Conn.

New York High Fidelity Music Show, Sept. 13-17, N. Y. Trade Show Bldg., 500 Eighth Ave., New York, N. Y. Institute of High Fidelity Mfrs., Inc., 125 E. 23 St., New York 10, N. Y.

IRE, Conference on Technical-Scientific Communications, Sept. 14-15, Philadelphia, Pa. Institute of Radio Engineers, PGEWS, Moore School of Electrical Engineering, Univ. of Pennsylvania, Philadelphia, Pa.

10th Annual Meeting, Standards Engineers Society, Sept. 18-20, Hotel Sherman, Chicago, Ill. F. M. Oberlander, Public Relations Chairman, RCA, Camden, N. J.

1st Fall Meeting, Enamel Div., American Ceramic Society, Sept. 20-23, French Lick-Sheraton Hotel, French Lick, Ind. American Ceramic Society, 4055 N. High St., Columbus 14, Ohio.

16th Annual Petroleum Mechanical Engineering Conference, Sept. 24-26, Muehlebach Hotel, Kansas City, Mo. Petroleum Div., ASME, 29 W. 39 St., New York, N. Y.

AWS, National Fall Meeting, Sept. 25-28, Hotel Adolphus, Dallas, Texas. American Welding Society, 33 W. 39 St., New York 18, N. Y.

7th National Communications Symposium, Oct. 2-4, Municipal Auditorium, Utica, N. Y. R. E. Bischoff, General Chairman, 19 Westminster Rd., Utica, N. Y.

SMPTE, 90th Convention, Oct. 2-6, Lake Placid Club, Essex County, N. Y. Society of Motion Picture and Television Engineers, 55 W. 42 St., New York 36, N. Y.

7th Annual U. S. Army Human Factors Engineering Conference, Oct. 3-6, University of Michigan, Ann Arbor, Mich. Chief Signal Officer, Dept. of the Army, Rm. BD1024, The Pentagon, Washington 25, D. C.

Overseas

Radio and Television Exhibition, Sept. 14-25, Parc des Expositions, Paris, France. Federation Nationale des Industries Electroniques, 23, rue de Lubeck, Paris 15, France.

Electronic Computer Exhibition, Oct. 3-12, Olympia, London, England. John Lodge, Public Relations Div., Pritchard, Wood & Partners Ltd., 197 Knightsbridge, London, S. W. 7, England.

LETTERS TO THE EDITOR

To the Editor:

With reference to the cover of the June issue and the caption on the Contents page . . . I will refrain from quibbling about the style: the "shattered" darkness and the searchlight beam "well beyond the moon," whatever this may mean. Permit me, however, to point out a few technical inaccuracies:

1. The arc is not an arc—the discharge is a flashover.
2. Since when is electricity measured in volts?
3. It doesn't "crackle": the discharge is one pistol shot.
4. The lightning-like bolts don't "climb up"—they better don't.
5. They don't "add" to the power—they are integral to the impulse generator's operation.

Also, I wonder whether the peak power, 100 megawatts (for what time?) is produced at 270 kv while the picture shows a flashover at 600 kv? All in all, a pretty sorry performance for a supposedly professional magazine.

Very truly yours,
Ludwig F. Rochmann, M'37

Dear Mr. Rochmann:

The constant problem facing every writer and medium is the reconciliation of reader interest and attention versus absolute reliance upon technical parlance to communicate properly. This problem is intensified where there are severe space limitations, as in picture captions. In the case of the photo caption on page 1 of the June issue of *Electrical Engineering*, with which you take exception, we attempted to explain, in as few words as possible, just what was transpiring in an obviously dramatic illustration. *Electrical Engineering* also wanted its readers to fully appreciate the illustration used for its cover. We feel these intentions were realized. Incidentally, we've rechecked the caption language with engineering specialists who reconfirm its accuracy.

So, with tongue in cheeck, due apologies to the fine editorial staff of the magazine, and relying on your sense of humor, we've rewritten that caption in strictly technical parlance:

"THE COVER: At the Sperry Gyroscope Company, division of Sperry Rand Corporation, Electronic Tube Division, Great Neck, N.Y., 600 kv is immediately generated by a Marx Generator as soon as any ionization occurs between cathode and collector in the klystron. This ionizes the air between the "crow-bar" spheres, discharging a 270-kv condenser that is connected between the cathode and collector of the klystron to prevent damage to the klystron by discharging the energy in the 270-kv storage condensers through the crow-bar circuit to ground. . . ."

Although it now contains many additional words, it conveys only about a tenth the information originally contained in the caption. It's a moot point whether there's improvement. Oh well, it *was* just a caption. . . .

Sincerely,
Ken Brigham
Public Information Manager
Sperry Gyroscope Company

Historical Note

To the Editor:

In the June issue appear two historical articles for which I, for one, am grateful, but the title of the Halacsy-Fuchs article "Transformer Invented 75 Years Ago" seems misleading. As the authors make clear, the transformer as a *device*, comprising two separate windings on a closed core, was devised by Michael Faraday some 130 years ago. What happened 75 years ago, after a long evolution interestingly portrayed by the authors, was the practical application of the transformer in an a-c system.

Despite the recognition given by the authors of the earlier contributions to the voltage-transforming device, including the open-core induction coil, one misses mention of the Ruhmkorff coil which preceded the power application of the transformer. It was a striking development in its day, for which Ruhmkorff received the prize of 50,000 francs at the French exhibition of 1858. This open-core type of transformer with its interrupter was a basic driver in that long study of vacuum-tube discharges which yielded the discovery of cathode rays and in turn the electron, also in the evolution of the radio transmitter. Let not ye power people forget the weaker-current communication side of the art! . . .

In the same issue, one can sympathize with Philip Sporn's view that the luster of engineering is being eclipsed by that of science in the public mind and in the minds of students. Yet, rather than being "cause for concern" should it not be cause for rejoicing? Is it not likely to instill into engineering more of the spirit of inquiry, and of the comprehensive view of man and matter, that characterize science? His own diagnosis bespeaks the need of a more comprehensive approach to engineering education. But, alas, youth is a doer, more than a thinker, and for the masses we can hope to accomplish only some of the ideals sought by Mr. Sporn.

Sincerely,
Lloyd Espenschied

Women as Engineers

To the Editor:

The article on engineering manpower appearing in the May issue of *Electrical Engineering* points up a grave mistake in masculine thinking. Out of approximately 3,850 words, about 60 words were devoted to women in engineering or 1.5%. Out of 36 paragraphs, 3 *sentences* referred to women. The article admits that only 2% of the capable college-age men can be channeled into engineering, that this percentage cannot be changed measurably, due to intelligence barriers, and other limiting factors. The comparison is drawn between our culture and that of Russia where 36% of the women enter science fields, of whom we may assume ¼ or 9% become engineers (using the approach Mr. Ingram followed for our assumption).

Then the possibility of helping American women attain engineering degrees is shelved completely in developing three methods of alleviating the manpower shortage, i. e., quantity, utilization, and quality, when already we have indicated that the quantity level of 2% is already at its maximum.

While I agree with the development of the other programs, I wonder at the disregard for the obvious method of immediately increasing by a factor of 2, our quantity figure. Instead of trying to increase, by a fraction of a per cent, the men graduating as engineers, why not aim at doubling the basic quantity by encouraging women? You are influential in the field. You should be the leaders in an effort to break the barriers for women. If you feel that it is worth while to improve quantity, quality, and utilization of male engineers, why then is it not also worth while to encourage by articles, speeches, and even working committees, the encouragement and support of women in the engineering profession?

Very Sincerely,
Faith M. Lee

To The Editor:

Responding to Mrs. Lee's letter provides a welcome opportunity to get myself on record with regard to my attitude toward women in engineering. That women are capable of contributing to our society as engineers is amply demonstrated by those women who graduate from our engineering schools each year (145 in 1960), by the example of the many successfully practicing women engineers, and by the existence of the very active professional organization, the Society of Women Engineers. The problem (and the pity) is that the numbers are so small. Mrs. Lee deplores this and so do I.

Why did I not stress in my article, as Mrs. Lee thinks I should have done, the availability of a large reservoir of potential engineering talent in the female sector of our population? The difficulties which exist to tapping it certainly have nothing to do with intelligence or aptitude. I cannot agree with Mrs. Lee that there are any insurmountable or even serious barriers to women obtaining engineering training or finding engineering employment. Most of our engineering schools admit women students, and most employers nowadays are happy to find qualified women engineers. The problem is that women do not in the main aspire to engineering careers. The real difficulty is with the cultural pattern of our society. The reason that the Russians have women engineers and we do not is that the cultural pattern in Russia is

different from ours. In Russia women follow industrial careers while at the same time pursuing family and maternal careers. In Russia, women engage in many occupations which our society reserves, traditionally even if unwisely, for men. I am not arguing the virtues of the Russian cultural pattern versus ours; I am only saying that cultural patterns are very real. They cannot be ignored. They change only by violent revolution, as in Russia, or by slow evolution as I hope they will here. In the meantime, in trying to make a sober and realistic assessment of our engineering manpower problem and what we can do to solve it, I cannot agree that there is any immediate prospect of increasing our additions to the engineering segment of our labor force from the female sector of our population by a factor of 2, or anything like it.

I believe that it is justifiable criticism of my article that in spite of these difficulties I did not include in the program something about encouraging more women to enter the profession. I am not sure whose responsibility it is to do something about it; government, industry, educational institutions, or the engineering profession. Actually, I am afraid I believe that the ones who can really do the most about it are the women themselves. I for one hope they do and that we all help them wherever we can.

Very truly yours,
S. B. Ingram

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

THE DESIGN OF SMALL DIRECT-CURRENT MOTORS. By A. F. Puchstein. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 407 pages, 6¼ by 9¼ inches, bound. $12. This book is a compendium of methods for solving the problems involved in the calculation and design of d-c machines. Methods are given both for those cases in which mechanical parts are available and for those in which no mechanical parts are available. In every instance, presentation of a method includes precise instructions, alternate procedures, numerical examples, and exact results. Emphasis throughout the book is on the electromagnetic aspects of design problems.

ELECTRICAL ENGINEERING. By S. B. Hammond. McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y., 1961. 566 pages, 7 by 9½ inches, bound. $8.75. Intended for the engineer whose special field of interest lies outside electrical engineering, this work provides a basic approach to the study of electric circuits. It discusses the characteristics of voltages and currents, electric networks, nonlinear resistive circuits, electron physics, electronic devices, linear and nonlinear operation, feedback circuits, analog and digital computers, magnetic fields and circuits, generation of voltages, and automatic control systems.

ADAPTIVE CONTROL PROCESSES: A GUIDED TOUR. By Richard Bellman. Princeton University Press, Princeton, N. J., 1961. 255 pages, 6¼ by 9½ inches, bound. $6.50. A unified approach to control theory is presented, and a technique is provided for making problems involving deterministic, stochastic, and adaptive processes of both linear and nonlinear type amenable to machine solution. Specifically, the theory of dynamic programming is used to formulate, analyze, and prepare these processes for numerical treatment by digital computers.

REFERENCE ELECTRODES. Edited by D. J. G. Ives and G. J. Janz. Academic Press, 111 Fifth Ave., New York, N. Y., 1961. 651 pages, 6¼ by 9¼ inches, bound. $20. This work provides a critical and selective compilation of information about the reference electrodes which are widely used in many branches of pure and applied electrochemistry. Among the electrodes described are the hydrogen electrodes, electrodes reversible to halide ions, the glass electrode, the quinhydrone electrode, and the metal–metal oxide electrodes. Also described are electrodes reversible to sulfate ions, membrane electrodes, reference electrodes in monaqueous solutions, and electrodes in fused salt systems. Emphasis is placed on applications in which accuracy of measurement is of prime importance.

ELECTRICAL THEORY ON THE GIORGI SYSTEM. By P. Cornelius. Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 1961. 1961 pages, 5¾ by 8¾ inches, bound. $6.00. Electrical theory is presented from a point of view expounded by Giorgi. The Giorgi (MKSA) system permits properties of electrical and magnetic fields to be expressed quantitatively in terms of the ampere and volt as units of current and potential. Throughout this work the author lays stress on the use of concepts based on electric and magnetic fields, derived from the concepts of current and potential difference. Thus, manipulation with field quantities offers few difficulties.

CYBERNETICS. By Norbert Wiener. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., Second Edition, 1961. 221 pages, 6¼ by 9¼ inches, bound. $6.50. This work deals with the application of statistical mechanics methods to communications engineering, with subject matter ranging from such control mechanisms as mathematical calculators to the nerves and brain of the human body. This edition has been completely re-edited, and contains two new chapters by Dr. Wiener on learning and self-reproducing machines and on brain waves and self-organizing systems.

POWER FROM WATER. By T. A. L. Paton and J. G. Brown. Leonard Hill (Books), Ltd., London, England, 1960. 210 pages, 5¾ by 8¾ inches, bound. 25s. The development of hydroelectric power in Great Britain is traced from its beginnings to the current large installations. The recent technical advances in methods and machines for hydroelectric production are outlined, and the economics of hydroelectric power in relation to other basic sources of electric energy is discussed. The prospects for its future application and further development close the book.

ELECTRONIC DRAFTING HANDBOOK. By N. M. Raskhodoff. Macmillan Company, 60 Fifth Ave., New York, N. Y., 1961. 402 pages, 6¼ by 9¼ inches, bound. $15. The principles and practices of electronic drafting are presented in this work which covers schematics, wiring diagrams, working installation drawings of electronics and communication systems and equipment, tube-base diagrams, and outline drawings. A number of finished sample drawings are given. Typical drafting-room practices and checking procedures for mechanical and circuit drawings are also described. A useful feature is the extensive reference section consisting of tables, drawings, and specifications.

ELECTRONIC PACKAGING WITH RESINS. By C. A. Harper. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 1961. 339 pages, 6¼ by 9¼ inches, bound. $11. The materials, methods, and techniques employed in the casting, potting, impregnation, and encapsulation of electrical and electronic components and systems are presented. Among the materials covered are polyesters, silicones, epoxies, urethanes, and polysulfides. Important modifiers such as fillers and diluents are also considered. Tools and fixtures, processing equipment, and manufacturing controls conclude the book. The contents are presented in a way that they should be readily comprehensible by readers having nonchemical backgrounds.

ENGINEERING DATA FOR PRODUCT DESIGN. Edited by D. C. Greenwood. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 1961. 430 pages, 8½ by 11½ inches, bound. $10. Practical information in the form of charts, tables, formulas, and facts is presented in this work, which is based on the Reference Book Sheets originally published in "Product Engineering." The material is presented in twelve sections dealing with general engineering; metals and alloys; non-metallic materials and finishes; components and general design analysis; beams, torque, and moment of inertia; bearings and shafts; gears; springs and vibration; mechanical control; fastening and joining; electricity and electronics; and hydraulics and pneumatics.

HANDBOOK OF INSTRUMENTATION AND CONTROLS. Edited by H. P. Kallen. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 1961. Various pagings, 6¼ by 9¼ inches, bound. $15. Data is presented to assist in selecting and effectively applying instruments and control systems for mechanical services in commercial, institutional, and industrial buildings. After a study of fundamentals, the reader is provided with both qualitative and quantitative data on pressure, temperature, flow liquid level, pH, and conductivity. These are then tied together in a detailed discussion of systems for boiler and power plants, heating plants, mechanical drives, air-conditioning ventilation, and refrigeration. Many control systems are completely illustrated to demonstrate modern practice.

Library Services

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NUCLEAR PULSE SPECTROMETRY. By R. L. Chase. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 16, N. Y., 1961. 221 pages, 6¼ by 9¼ inches, bound. $8.50. The electronic techniques and physical principles related to the problems of cataloging the electrical signals from nuclear radiation detectors are described. The range of material covered includes nuclear radiation detectors, pulse amplifiers, pulse height and time distribution analyzers, coincidence systems, factors affecting design of linear pulse amplifiers, analyzer linearity and stability, analog-to-digital conversion schemes, data-storage systems, photographic recording of pulse data, and multidimensional spectrometers. The text is directed at a qualitative appreciation of the problems met in nuclear spectrometry, and mathematical expressions are used only to establish those relationships not easily arrived at by qualitative discussion alone.

INTRODUCTORY SYSTEM ANALYSIS. By W. A. Lynch and J. G. Truxal. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 1961. 445 pages, 6¼ by 9¼ inches, bound. $7.50. The basic analysis techniques common to the areas of analog simulation, electronic instrumentation, communications, automatic control, digital computation, electric machinery, and electric power generation and distribution are discussed. Unusual topics treated in the text include analog computers, complex-frequency techniques and the essential results of the Laplace transform, signal analysis, mechanical and other networks, and signal flow graphs. The text is marked by an unusually broad approach to the subject of electrical engineering.

INTRODUCTION TO NUCLEAR ENGINEERING. By R. L. Murray. Prentice-Hall, Inc., Englewood Cliffs, N. J., Second Edition, 1961. 384 pages, 6¼ by 9¼ inches, bound. $12. This is a concise presentation of the physics of neutrons, fission, and radioactivity, and how they apply in the design, construction, testing, and operation of equipment employing nuclear fission processes and materials. This edition provides extended treatment of particle accelerators, fuel production and consumption, fuel costs, properties of new materials, shielding analysis, reactor experiments, isotope uses, direct conversion, ion propulsion of space vehicles, and thermonuclear devices. A new sequential reactor design has been developed.

TENSOR ANALYSIS OF ELECTRIC CIRCUITS AND MACHINES. By L. V. Bewley. The Ronald Press Co., 15 E. 26th St., New York 10, N. Y., 1961. 309 pages, 6¼ by 9¼ inches, bound. $12. The essential principles and applications of the matrix-tensor methods of analysis of electric circuits and machines, originally formulated by Gabriel Kron, are discussed. This work is intended to provide a unified consolidation of developments in this field and to serve as an introduction to the usefulness of tensor methods in electrical engineering. It is divided into two parts, the first covering matrices, tensors, and circuits, and the second covering machine analysis.

AN INTRODUCTION TO THE THEORY AND PRACTICE OF TRANSISTORS. By J. R. Tillman and F. F. Roberts. John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 340 pages, 5¾ by 8¾ inches, bound. $8. The first part of this text presents the basic physical theory of semiconductors and transistors. An analysis of a practical three-dimensional model of a transistor gives a realistic account of its properties. The second part covers the preparation of monocrystals of germanium and silicon of controlled purity, and outlines the techniques used to produce junction devices. The properties of transistors and diodes are described, and many of the basic circuits in which they are used are surveyed.

ITERATIVE ARRAYS OF LOGICAL CIRCUITS. By F. C. Hennie, III. John Wiley Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 242 pages, 6¼ by 9¼ inches, bound. $4.95. The properties of the various classes of iterative systems and the various tests that are available for answering simple questions about them are developed in a logical fashion. It is shown that there are no general procedures for answering most of the basic questions about iterative networks. The techniques that are presently used for designing and simplifying sequential switching circuits are then extended to various types of iterative networks.

NUCLEAR ENGINEERING. By Gilbert Cahen and Pierre Treille. Allyn and Bacon, Inc., 150 Tremont St., Boston, Mass., 1961. 394 pages, 6½ by 9 inches, bound. $8.50. This translation of a French work provides a broad coverage of nuclear engineering. Beginning with the physics underlying nuclear engineering, it continues with nuclear reactor theory, nuclear reactor materials, and a description of French, British, and Soviet reactors. It concludes with an examination of the hazards as well as the beneficial uses of radiation. Conversion tables, nuclear data tables, and many charts and graphs are included.

THE INTERNATIONAL DICTIONARY OF PHYSICS AND ELECTRONICS. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., Second Edition, 1961. 1355 pages, 7½ by 10¾ inches, bound. $27.85. An enlarged and revised edition of a standard work that now includes recent developments in such areas as thermonuclear research and magnetohydrodynamics, nuclear physics, atstrophysics, and electronics. The terms defined include laws, relationships, equations, basic principles and concepts, as well as the most widely used instruments, apparatus, and their components. An attempt has been made to remove redundant entries and to make entries easier to locate by the choice of initial words that are likely to be the ones that occur to the user. An important addition is a multilingual index in French, German, Spanish and Russian.

MAGNETIC CONTROL OF INDUSTRIAL MOTORS, PARTS 1 & 2. By G. W. Heumann. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 2 volumes, 6 by 9¼ inches, bound. $18. Industrial type a-c and d-c motors are carefully analyzed in conjunction with their associated controllers. Motor performance data for the a-c squirrel-cage, wound-rotor, and synchronous motors are presented, as well as data on d-c series and shunt motors. Principal circuits, selection of controller sizes and components, economic factors affecting controller selection, motor protection, and existing safety codes and standards are given complete coverage.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

STREET LIGHTING AND ACCIDENTS. Prepared by the International Commission on Illumination, publication no. 8 is a report summarizing a study on the influence of street and highway lighting on the number of traffic accidents. Printed in French, English, and German, it contains 28 pages within stiff covers. It may be obtained from M. Jean J. Chappet, Commission Internationale de l'Eclairage, Bureau Central, 57 rue Cavier, Paris 5e, France, for $2.

RECOMMENDED LEVELS OF ILLUMINATION. A section of the official Lighting Handbook of the Illuminating Engineering Society, showing the minimum recommended levels of illumination for every task, has been newly reprinted and made available to manufacturers and electric utilities. The booklet replaces all previous publications on this subject. The 16-page reprint may be obtained at 20¢ a copy from the I. E. S., 1860 Broadway, New York 23, N. Y.

NATIONAL FIRE PROTECTION ASSOCIATION. Two publications concerned with the electrical and electronic industries are now available. *Electronic Computer Systems* gives tentative recommendations for controlling fire problems in the installation and operation of these systems, and is printed to be available for review by manufacturers, users, and others concerned with electronic computers. *NFPA no. 75-T, 50¢. Proposed Amendments to the 1959 National Electrical Code* includes changes which would affect many kinds of commercial, industrial, and domestic installations. Among the projected amendments are clarification of the 6-foot rule in dwelling receptacle spacing, and new definitions of stationary and fixed appliances, as opposed to portable appliances. The revisions are being reviewed in preparation for the 1962 edition of the Code. *NFPA no. 70 PR-1961, $2.50.* These publications may be ordered by number from the National Fire Protection Assn., 60 Batterymarch St., Boston 10, Mass.

AMERICAN STANDARDS ASSOCIATION. Two new standards of interest to the electrical field have been published by the ASA. *American Standard Nomenclature for Glass Bulbs Intended for Use With Electron Tubes and Electric Lamps, C79.1—1961,* specifies the use of the third letter symbol covering changes in anode connectors over an existing designated bulb. It immediately follows the second number symbol which covers characteristics below the CD line, and will be assigned in alphabetical order, beginning with the letter "A." $1. *American Standard Specifications for Multiple V-Belt Drives, B55.1—1961* comprises five V-belt cross sections and sheave groove sizes. It provides dimensions and recommended installation procedures for integral-horsepower V-belt drives used primarily for power transmission in industrial applications. Tables are provided for suggested service, length correction and other factors. $2. Copies of the standards should be ordered by number from the American Standards Association, Dept. P 244, 10 E. 40 St., New York 16, N. Y.

CHANGE OF ADDRESS

All communications to AIEE and to Electrical Engineering should be addressed to our new quarters at

345 East 47 Street
New York 17, N.Y.

OTS REPORTS. The following publications have been made available to the public by the Office of Technical Services. *A New Electrochemical System for High-Voltage Low-Current Drain Applications,* by W. J. Pauli. Tiny 6-volt batteries, developed to charge capacitors, and retain their power at −65 F after shelf storage of more than a month at +125 F, are described. *Order no. PB 171 582, 19 pages, 75¢. Ceramic Tubes Developed for External Heat Sources,* by John F. Richter. This describes a metal-ceramic tube of planar design, heated externally by a radioisotope, which has passed proof-of-principle tests and warrants further development. *Order no. PB 171 492, 37 pages, $1.25. Design Analysis of a Prepackaged Nuclear Power Plant for an Ice Cap Location.* Design and operational requirements of a prepackaged nuclear power plant for use in tunnels beneath frozen ice caps are summarized in this analysis recently made public by the Atomic Energy Commission. *Order no. APAE-39, 459 pages, $5.50. Peltier Heat Pumps—Application Parameters and Device Possibilities,* by H. F. Gibson. The design theory of Peltier heat pumps and their possible application in ordnance electronics are discussed. *Order no. PB 171 559, 11 pages, 50¢. The Dynamic Compressibility of Solids from Single Experiments Using Light Reflection Techniques,* by N. L. Coleburn. A technique developed by the Navy to determine in a single experiment the dynamic compressibility of solid over a large pressure range is described. *Order no. PB 171 686, 53 pages, $1. Radioactive Control and Regulation Methods of Industrial Processes,* N. N. Shumilovskii (editor). This translation of 26 papers by Soviet scientists shows how the Soviet countries are moving forward in perfecting radioactive controls and regulation of industrial production. *Order no. AEC-tr-4139, 310 pages, $4. An Investigation of the Hygienic Characteristics of Ultrasonic Waves in Industry.* This translation of an article from a USSR medical journal concludes that workers exposed to ultrasonic waves and intense high-frequency noises show marked physiological reactions, including a tendency toward hypertension. *Order no. 61-31468, 50¢. Foreign Developments in Machine Translation and Information.* This translation of a Soviet report on the problems of scientific communication shows that a Soviet scientist may spend half the working day reading in his field, and gives results of a study made in an effort to develop more efficient processing of scientific material. *Order no. 61-31465, 48 pages, $1.50. Manual of Semiconductor Triodes and Diodes.* This is an English translation of a Soviet electronics handbook containing general and detailed data on transistors and semiconductor diodes. *Order no. 61-31116, 450 pages, $6. Introduction to Quantum Electrodynamics,* by A. A. Sokolov. Physical bases of quantum electrodynamics and "computational methods" of this theory are discussed in a translation of a 2-volume work by a Soviet scientist. *Order no. AEC-tr-4322, 558 pages, $6.50.* These publications may be ordered from the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

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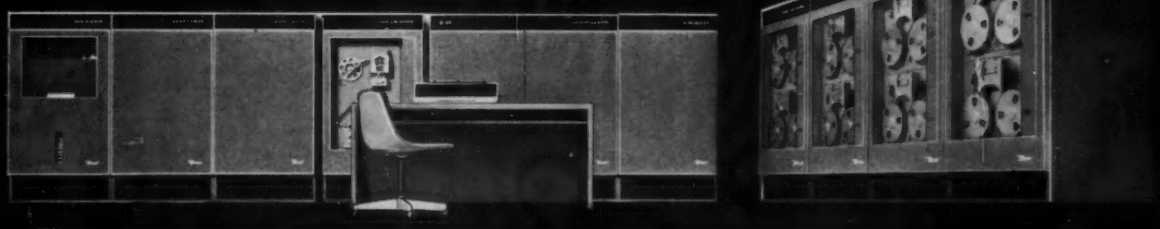

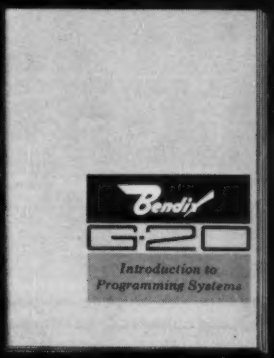

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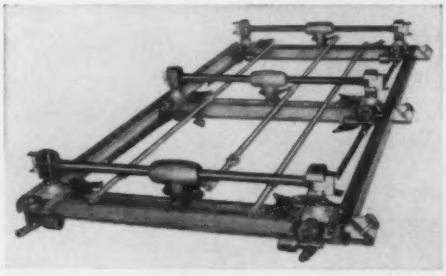
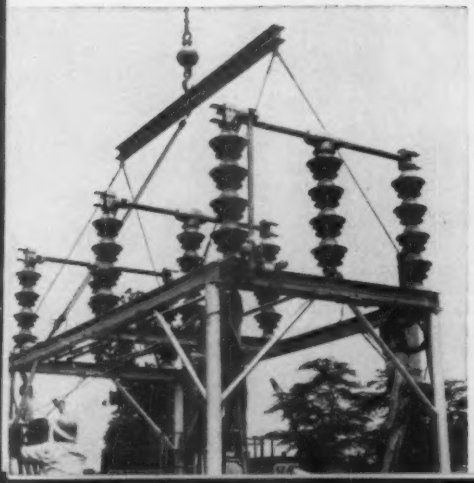
Above is a partial view of the Ravenswood Substation showing some of the switches in place on the aluminum stands. In all, there are 54 disconnect switch structures as well as a variety of structures for bus supports, lightning arresters, coupling capacitors and wave traps, cable potheads, and potential transformers.



Preassembled welded aluminum switch structure as it arrived from the factory. Switch bases are integral with frame. Grounding switches and their interphase rods were also factory installed in many cases.



The photograph at left shows the special sling used to lift the switch package into position on the leg sections. The columns for a typical stand were installed in approximately 10 minutes; insulators were installed in a little over an hour, and the switch lifted and bolted into position in less than 15 minutes.

RAVENSWOOD GOING UP...

A NEW CONCEPT IN SUBSTATION DESIGN AND CONSTRUCTION

Ravenswood transmission substation which serves Con Edison's big new generating plant along the East River in Long Island City, New York, is going up smoothly and quickly. One of the major factors contributing to the speed and ease of its erection is a bold new concept in substation design and construction: factory preassembly of switch structures.

The original idea for these packaged structures came about as a need voiced by Con Edison's engineers. Working with them on the project, Southern States' Structural Engineering Department conceived a practical design permitting much assembly work normally accomplished in the field to be done at the factory.

Ravenswood, the world's largest aluminum transmission substation, was the first practical application for this concept. When construction started, these compact, easily handled units were in the field ready for installation. They consisted of completely assembled welded aluminum frames with integral switch bases, interphase rods, and components of the switch mounted in position. By simply removing the switch live parts and reassembling with insulators, the packaged structures, with switches already adjusted, were ready for installation. In addition, factory fabricated aluminum stands further reduced the number of hours required to get a switch installed.

Some of the advantages of this approach are readily apparent. Contrast the handling required for these factory assembled switch structures to the conventional method of shipping all pole units separately. Further, in usual practice, all interphase rods, clevises, adjustable arms, grounding shunts, and numerous nuts and bolts are unassembled when they arrive at the job site. As construction engineers will confirm, a lot of valuable time is spent sorting and preparing such switches for mounting. And once the switches are in place on their stands, interphase rods have to be installed and the switch completely adjusted for proper opening and closing. (The packaged units require only a minor adjustment of tilting rings after the switch is installed.)

According to Con Edison, savings at Ravenswood are significant.

Although the use of aluminum structures and aluminum stands as employed on this station may not be practical in some areas and for some utilities, the principle involved may represent a real breakthrough in substation construction. For example, the basic idea could be easily applied with factory assembled, bolted steel sections for mounting on any type of stand whether aluminum, steel column, or conventional structure.

With labor costs skyrocketing, serious consideration should be given to the practicability of factory preassembly of switch structures for your next substation.

Why not discuss this new idea with your Southern States representative or contact us direct for additional information?

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If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application.

A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

MEN AVAILABLE

New York Office

ELECTRICAL OR NUCLEAR ENGINEER, Master in Electrical Science, (30 credit hours in Nuclear Engineering), experienced as an electrical engineer and assistant master mechanic in mines. Location of position—South America—12 years. Consulting Electrical Engineer in systems planning and steam plant design—10 years. Operating Instrument Reactor Control—Two years. Speak five languages. $8-$10,000. Location: Anywhere. E-259.

ENGINEERING MANAGER OR CONSULTANT, B.S.E.E.: Registered P.E.—U.S. Patents, age 51. Scientific and practical "know-how." Eighteen years' (eight managerial) broad experience device development, design and manufacture. Technology areas: electron emission, cathode ray, gaseous electronic discharge, high-vacuum, piezoelectricity, fluorescent screen, thin film vapor deposition, plastic molding, Newtonian mechanics. Salary open. Location: Prefer East—Home, Mass. E-260.

AUTOMATION DESIGN—PLANT ENGINEERING, B.E.E. Three years' engineer with supervisory background, desires industrial control design or supervision in a related field. $7-$8000. Location: New York City area. E-261.

Chicago Office

ELECTRICAL DESIGN ENGINEER, B.S.E.E., age 34. Eight years in: Large chemical plant, design of lighting and power systems, automatic control circuit design, field supervision, maintenance scheduling and supervision. $9600 a year. Location: South, Southwest, Southeast. E-2242—Chicago.

ELECTRICAL ENGINEER, POWER, B.S.E.E., age 48. Experience in control and relay panel design, protective relay setting and application, automatic oscillograph analysis. Registered P.E. $7400 a year. Location: Preferably Midwest. E-2243—Chicago.

MANAGER, ELECTRIC UTILITY, B.S.E.E., M.B.A., age 38. 12 years electrical work, including six years responsible administrative positions, three years manager of 1500 meter utility (generation and distribution). $9000 a year minimum. Location: Midwest or West. E-2244—Chicago.

ELECTRICAL ENGINEER, B.S.E.E., Reg. Indiana and Michigan, age 33. Ten years design, production engineering and development testing on engine ignition systems, DC motors and generators and gas turbines. $10,000 a year. Location: Midwest preferred. E-2245—Chicago.

SALES ENGINEER, B.S.E.E., age 43. Sales engineer with customer oriented attitude seeks opportunity with manufacturer wanting Chicago representation. Primary interest, electro-mechanical products. Wide experiences, sales, service, application of high & low voltage electrical control, heat treating and brazing. Salary plus commission. E-2246—Chicago.

COMMUNICATION ENGINEER, B.S.E.E., age 27. Experienced in all phases of plant department of a telephone utility in outside plant, central offices, engineering group and on subscriber premises. Worked as a liaison engineer for the Ordnance Corporation in the guidance central position for guided missile system. $8000 a year. Location: Chicago. E-2247—Chicago.

ADMINISTRATIVE ENGINEER OR PROJECT MANAGER, electrical engineer and business administration, 63. 25 years in responsible charge A.E. organizations and construction management large R & D projects, power and industrial plants, hospitals, commercial buildings want interesting affiliation with consultant, A.E. organization or manufacturing. $12-$20,000. Location: U.S.A. E-2248—Chicago.

San Francisco Office

DESIGN, DEVELOP-ELECTRONICS, ELECTRO MECHANICAL: age 34, ME, ASME. Prefer San Francisco Bay Area. Home: California. $1,000. Eleven years varied design and development and development of electro-mechanical components and products including manufacturing experience (plant facilities, production). Se-1691

ELECTRICAL ENGINEER-INDUSTRY: age 39, EE, AIEE. Prefer West United States or foreign. Home: Texas. $650. Experience in power and distribution facilities, project engineer, relay applications, control circuits and control boards, economic studies of proposed projects. Twelve years broad experience in power field. Se-1322

TRAINEE-ELECTRONICS: age 26, Electronics. Prefer any location. Home: Oklahoma. $475. Recent graduate desiring electronics engineering, servo mechanisms, research and laboratory. Se-898

PLANT ENGINEER-INDUSTRY: age 37, EE. Prefer California area location. Home: Washington. $1,000. Eight years experience field engineer for major electrical equipment, installation, operation, repair all types major electrical equipment. Five years supervise of field engineers. Se-827

ELECTRICAL DRAFTSMAN-MANUFACTURING, CONSULTANT: age 28, electrical background. Prefer San Francisco Area. Home: California. $570-$700. Over six years experience as an electro mechanical draftsman automatic cross bar telephone exchanges, electrical controls and switchboard circuits and shop drawings. Se-1043

DRAFTSMAN-ELECTRICAL: age 21, two years college engineering. Prefer San Francisco Bay Area. Home: California. $400. Extensive home experience in electrical drawing and construction of electrical tools and communication systems. Se-1184

ELECTRICAL ENGINEER-HEAVY ELECTRICAL CONSTRUCTION: age 43, EE, AIEE. Prefer any location. Home: Washington. $1400. Experienced in organizing office, setting procedures and standards, scheduling and detailing construction drawings, equipment and material specifications, supervising construction including high voltage transmission lines, testing apparatus and controls and starting up. Se-507

ELECTRICAL ENGINEER: age 24, MS EE. Prefer San Francisco Bay Area. Home: California. $500-$600. Recent graduate with work beyond Masters Degree in Electrical Engineering. Se-522

SALES ENGINEER-ELECTRICAL, MECHANICAL: age 27, electrical background. Prefer San Francisco Bay Area. Home: California. $600 up. Over two years sales experience with good sales record to industrials, contractors, engineers and electrical distributors, selling electrical wire, cable, cranes and hoisting machinery, materials, handling equipment. Se-128

PRODUCTION PLANNING, INDUSTRIAL-ELECTRONICS: age 29, industrial management background. Prefer San Francisco Bay Area. Home: California. $500. Broad experience in production scheduling, methods improvement studies, all phases of production control and liaison between administration and engineer in computors and related. Se-276

SALES MANAGER-ELECTRONICS: age 32, EE, Bus. Admin. Prefer any location. Home: Michigan. Five years sales experience including product planning, market research, advertising, market administration, market studies, competition analysis, budget analysis in generators, diesel engines, jet engines, electronics. Se-416

RESEARCH, DEVELOPMENT, DESIGN-ELECTRONICS: age 25, EE, MS Math. Prefer San Francisco Area. Home: California $525. Recent graduate. Se-248

MARKETING MANAGER-ELECTRONICS, POWER: age 32, EE. Prefer any location. Home: Michigan. Five years experience as director of sales, product planning, market research, designer in power equipment, electronics. Se-608

POSITIONS AVAILABLE

New York Office

INSTRUMENT ENGINEER, B.S. in chemical or electrical engineering for position in Research and Engineering Department. Experience in application of instruments in petroleum or chemical plants required, preferably five to ten years. East. W618(a).

EDITOR, mechanical or electrical, trade publication, to plan, develop and produce editorial material in the field of energy systems engineering. Experience in steam generation and/or instrumentation and control preferred. Some travel. $10,000 a year. New York City. W608.

RESEARCH AND DEVELOPMENT ENGINEER, graduate mechanical or electrical, with 5 to 8 years' experience in product engineering and also experience in preparing technical reports, brochures and proposals. Position involves research and development of a mesh contact to be used in relays, switches, choppers and computers. Will also be responsible for working with customer and do a considerable amount of sales engineering. $9-$12,000 a year. New Jersey. W607.

CONTRACT ADMINISTRATORS with a minimum of five years' experience in electronic industry. Familiarity with government regulations and proposals. Must be capable of complete administration of military contracts. Law degree or technical background preferred. To $13,100 a year. Lower Conn. W602.

ENGINEERS. (a) Production Manager, graduate electrical, with a minimum of five years engineering experience supervising production department of medium size electronic company engaged in subsystems equipment. Knowledge of Digital printed circuit boards required, and metal work techniques helpful. To $18,000 a year. (b) Standards Engineer, graduate electrical, qualified to set up standard components section. Experienced in compiling a "Standard Components Manual" as a guide for R & D engineers in the design of new equipment and to help write components specifications. To $13,500 a year. Lower Conn. W601.

ENGINEERS. (a) Engineering Section Heads, advanced E.E. degree and minimum of two to five years experience in supervising engineers and technicians. Heavy digital circuitry with computer application and magnetic core experience. To $20,000. (b) Physical Design Section Head, graduate electrical, with ten to 20 years heavy experience supervising and organizing company activities in mechanical design (electronic packaging), drafting, printed circuit design, standards, release procedures, drawing control, etc. To $18,000 a year. (c) Electronic Engineers, graduate electrical, with two to ten years experience in circuit design for transistors and/or computer type circuits; design and testing of military equipment. To $14,500 a year. Lower Conn. W600.

ENGINEERS. (a) Senior Engineer, graduate electrical, with five to ten years' design and construction experience in all phases of industrial power control and lighting. P.E. license preferred. Must have experience in 12 to 14 KV range. Will handle complete electricals for air separation and chemical plants including scheduling, specifying, requisitioning, designing, coordinating and inspecting. To $10,200 a year. (b) Senior Engineer, with seven to ten years experience as mechanical or project engineer in the design and construction of cryogenic, chemical or petrochemical plants. Will be responsible for all design procurement, construction and start-up of a single project. To $10,800 a year. Periodic field trips on both positions. Central N.J. W579.

DIRECTOR OF SYSTEMS ENGINEERING, graduate electrical or mechanical engineer, with a minimum of 12 years experience, six of which should have been a supervisory level. Duties and responsibilities will embrace all activities relating to the proposals and installation of communication systems. Will confer with industrial, educational and government communication systems. Will confer with industrial, education and government communications systems salesman; review estimates of cost and preliminary time schedule for engineering work and installation; maintain liaison with customers on matters of design, costs, schedules, revisions and other matters. $12-$15,000 a year. New York City. W564.

ESTIMATOR, electrical graduate, for electrical contractor, with five years experience in public and private wiring, light and power. Salary open. Brooklyn, N. Y. W561.

GENERAL MANAGER, graduate electrical or mechanical, with at least ten years managerial, production and engineering experience in wire and cable for electric power use. $20-$25,000. New England. W550.

DESIGN, DEVELOPMENT ENGINEERS, graduate mechanical or electrical, or physicist, to design and develop a new line of high power R-F, microwave and pulse components for the electronic industry. Experience in the design of terminations, attenuators, directional couplers and isolators highly desirable. Apply by letter listing salary requirements. $8-$10,000 a year. Upstate N. Y. W542(b).

ENGINEERS. (a) Microwave Engineers with three to 10 years experience in microwave circuitry such as filters, antennas, hybrid rings, oscillators and transmitters. (b) Electronic Engineer with seven to ten years experience in tube and/or transistor circuitry such as IF amplifiers, frequency multipliers, oscillators, transmitters, modulators, etc. Salary open. N. J. Shore area. W538.

HEAD OF ELECTRICAL ENGINEERING DEPARTMENT, Professional rank, Ph.D. preferred but will consider M.S. and extensive teaching or industrial experience. $9800 for ten month employment period. South. W537(b).

VICE PRESIDENT, graduate electrical, with some knowledge of the piezo electric tube field products. Should be able to culminate top level negotiations and licenses with large corporations, handle subcontracts and be chief administrator of the company. $18-$20,000 a year, plus stock options. New York City. W528.

PLANT ENGINEER, graduate electrical, to supervise electrical maintenance in chemical plant and work with electric utility company on plant changes. About $8500 a year. Nevada. W517.

Chicago Office

LOGIC CIRCUIT DESIGNER, B.S.E.E., B.S. or equivalent engineer. Duties: Layout and design machine tool circuit controls. Consult with machine tool builder on control circuit requirements. Integrate special control circuits into established electronic machine tool control system. Follow designs and projects from manufacturing stage to final user installation. Assist in improvement of manufacturing technicians and product packaging, development, manufacture and sale of numerical control systems for machine tools. Employer will negotiate placement fee. $7200-$9000. Michigan. C8730.

DEVELOPMENT ELECTRONIC ENGINEERS OR PHYSICISTS, graduates, with advanced degrees preferred. To handle projects on data computing, and processing techniques, experience in magnetic recorders, transistor circuit development. Experience in preparation of engineering proposals and reports. Classified work therefore must be U.S. citizen with security clearance. Long range development program with good potential for a manufacturer. Employer will negotiate placement fee. $10-$15,000. Chicago. C8726.

TRANSFORMER OR MAGNETICS ENGINEER, graduate E.E. or Physics and a minimum of two years' experience in design of power transformers from 50 VA to 1000 VA. This man will carry out design of special transformers, chokes, and some nonlinear magnetic devices in the above power range. $7500-$10,000 a year. Employer will pay fee. 30 miles Northwest of Chicago. C8714.

ENGINEERS. (a) Assistant Director of Sales, B.S.E.E. Must have at least five years in sales and/or sales administration in a related product area to power suppliers, transformers or other electro-mechanical components. Duties: Direct and coordinate activities of sales engineers, manufacturers agents and field offices. Aid sales manager in determining market opportunities and requirements on new products. Assist in formulating sales policies. Contact sales personnel and customers, hold meetings with sales, manufacturing engineering and other personnel, prepare sales reports, assist in selecting and training sales engineers for a manufacturer of power supplies and controls. Employer will pay fee. (b) Sales Engineer, graduate E.E., with two or more years' sales experience in related products. Duties: Contact government and military agencies in Washington and other locations to obtain contracts for sales of products. Act as liaison between home office and government facilities with regard to specification, contracts, delivery dates, technical assistant, etc. Assist in determining marketing opportunities for existing and new products. Visit and correspond with government agencies, hold meeting, prepare sales reports in accordance with sales policies. Will report to Director of Sales. Headquarters: West N. Y., but will spend 50% of time in Washington or other government installations for a manufacturer of power supplies and controls. $10-$12,000. Employer will pay placement fee. C8694.

DESIGN ENGINEER, B.S.E.E. for employment with electrical consulting firm. Experience in motor controls, lighting, power, general construction. Salary open. Albuquerque, N. Mex. C8689

TEACHING PERSONNEL, B.S. or better; three or more years experience in industry augmented by some teaching work. (a) Mechanical Engineer to teach machine design; (b) Industrial Engineer to act as head of I.E. Department. (c) Electronics Engineer to act as head of department; Rank depends on experience; salaries range from $5600-$9600 based on nine months depending on experience; good opportunity relatively new and growing school with present enrollment of 3100—1200 of which are engineering. Location, Southern California. C8771.

ENGINEERS. (a) Product Design Engineers, Senior and Junior: Senior, must have a minimum of six years' experience in mass production techniques and broad experience with the design of machined parts used in small electro-mechanical apparatus. Duties: Design and development of electric shavers. $10-$12,000 a year. (b) Junior Design, minimum of four years experience same as outlined above. To $8500 a year. Employer will pay placement fees. Location, Illinois. (c) Test Engineer, graduate E.E., with two or more years experience in research lab as test engineer on electro-mechanical devices. Duties: Testing of experimental models of electric appliances, shavers and motors; set up tests, evaluate results, prepare reports and make recommendations to design engineers for a manufacturer. Employer will pay fee. To $8500 a year. Location, Illinois. C8772.

DIRECTOR OF RESEARCH AND DEVELOPMENT, graduate engineer. Must have a minimum of 10 years experience in research and development and have supervisory ability to direct and supervise research and development of capacitor laboratory, electrolytic, paper, oil and motor starting condensers for all applications, for a manufacturer. Salary open depending on experience. Employer will pay fee. Location, Chicago. C8732.

San Francisco Office

SALES-COMPUTER: $18,000, in San Francisco, Pennsylvania, Washington DC, BS plus Bus Ad. Eight to ten years large scale computer sales. Five years supervising others, demonstrated ability, knowledge of sales, budgeting, programming. Will manage promotion, sale, installation, service and follow up of computer and equipment in region, supervising and monitoring district offices, maintaining adequate forces, set up and direct sales campaign, local shows and conventions, conducts customer seminars, coordinates with societies, schools, obtain established quotas. Agency fee, interview, relocation fee paid. Security clearance. Sj-6315

MANAGERS, APPLICATIONS-MAGNETIC RECORDERS: $15,000, $12,000, in Illinois, in California, EE, age to 45. One for Staff Manager, one for West Coast Manager. Know application of magnetic recording heads, analog or digital. Able to screen and handle inquiries, handle client or conference demonstrations, familiar with requirements of developing pricing philosophy, interpret military or private clients needs as to product, deal with management and top technical levels. For a manufacturer. United States Citizens—clearance required. Sj-6338

SENIOR DESIGNER—POWER HOUSE: $10-12,000, in San Francisco, EE, age about 50. Minimum fifteen years heavy experience supervision, designing major hydro-electric power houses. For an engineering consultant firm. Sj-6284

ELECTRONICS DESIGNER—CONTROL SYSTEMS: $12,000 approximately, in San Francisco East Bay, EE or ME with electronics, age to 50. Well experienced in creative electronics as applied to hydro-pneumatic electro-mechanical control and actuating systems. Familiar with servos, mechanics, circuitry, and unique applications of complex systems. For a manufacturer—engineer. Sj-6263

(Continued on page 44A)

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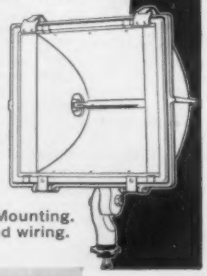

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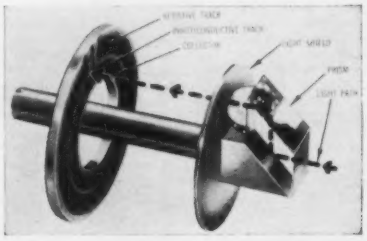
(Continued from page 22A)

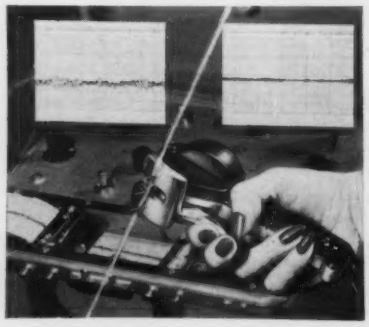
Potentiometer . . .

Physical contact between the wiper arm and the resistive element is eliminated in recently developed potentiometer called the Betapot. The new component utilizes a source of light for pick-off, beaming a stream of photons through a thin film of photoconductive semiconductor material. The semiconductor reacts to light by becoming immensely conductive. The movable light beam thus defines a path of high conduction between the annular collector and resistive elements. Virtually infinite life is claimed by the manufacturer for the unit because of the frictionless pick-off action. *Duncan Electronics, Inc., 2865 Fairview Rd., Costa Mesa, Calif.*



Tension Recorder . . .

Tension and its changes are recorded during all preparatory operations of wires, cables, tapes and yarns, as well as cordage, with a new tension recorder. The device shows quickly any changing tensions electrically during the preparation of wires and cables at full speed. In the accompanying illustration, the record in the upper area shows tension of the same material coming from a pirn as compared to delivery from a spool. With identical settings, the record at the right shows a lower, more uniform tension while that on the left has greater variations, thus subjecting the sensitive wire to damage. *Tensitron, Inc., P. O. Box 185, Harvard, Mass.*



Film-Coated Magnet Wire . . .

Continuous high-temperature operation up to 250 C and resistance to heat shock up to 425 C are features of Anaconda ML, a new film-coated magnet wire. The heat stability of the wire permits reduction in electric motor sizes since motors using the new wire can run hotter. Other advantages of the wire include: high burn-out resistance; thermoplastic flow above 500 C; dry dielectric strength above 3,000 volts per mil; excellent flexibility, windability, and scrap resistance. *Anaconda Wire and Cable Co., Hastings-on-Hudson, N. Y.*

Solid-State Switch . . .

No transients are introduced into the power line when the load is switched off and on the line with a new solid-state switch. There are no contacts to arc or spark or weld when changing the load. Models are available for 5-, 10-, and 20-ampere load circuits at 115-volt operation. Multiple switching combinations are possible for multiple load circuits from common input contacts. *LJ Products, 7464 Girard Ave., La Jolla, Calif.*

Temperature Monitor . . .

Especially useful where critical items are being tested and would be destroyed if the temperature exceeded or fell below specified limits, this new temperature fail-safe unit also serves as a pyrometer to indicate temperature of a device at any given time. When a temperature limit is reached, the temperature chamber in which the devices are being tested is automatically turned off and cannot be turned on without a manual reset. The unit is fail-safe and includes an alarm circuit to allow the unit to be connected to existing plant alarm systems. Units are now available to control spans as small as 20 F between over-all limits of −100 F and +500 F. Other units will cover −100 F to +1,000 F and higher. *Delta Design, Inc., 3163 Adams Ave., San Diego 16, Calif.*

Surface-Mounted Transformer . . .

A low-profile, single-phase surface-mounted residential transformer is now available in sizes 25- through 50-kva models, 10 kv and below, with secondary ratings at 240/120. One third smaller and lighter than existing units, the transformer weighs 750 pounds, occupying a scant 3-foot square area. A high-voltage interrupter switch is capable of interrupting full load. *Allis-Chalmers Manufacturing Co., Milwaukee 1, Wis.*

High-speed computers are able to process data many times faster than the data can be entered manually from the checks, invoices, premium notices and other documents that are the source of most business information. Now IBM has developed a character-sensing system that can "read" numerical data right from printed documents and translate it for direct input to a computer at the rate of 480 characters a second. The system is able to read type styles used by IBM accounting machines.

The IBM engineering group that developed this remarkable system started its inquiry with a theoretical question: What amount of information must a machine acquire and maintain in order to distinguish one character from another? The investigation then ranged across many technical boundaries—optics, for developing scanning methods; photosensing, for converting the light image into electric impulses; electronic circuit design, for converting the analog signals of characters to digital information; and statistical analysis, for creating logic capable of distinguishing between the many character patterns. The next step for this engineering team is to develop equipment that can recognize alphabetic and special characters.

This wide-spectrum approach to problem-solving is typical of the development work IBM currently is doing in such areas as control systems, semiconductors, polymers, and optics. It is an approach that requires people who can think creatively. In turn, it provides these people with an unusual opportunity to grow professionally and personally. If this approach interests you—and you have a degree and experience in engineering, mathematics or one of the sciences—we'd like to hear from you.

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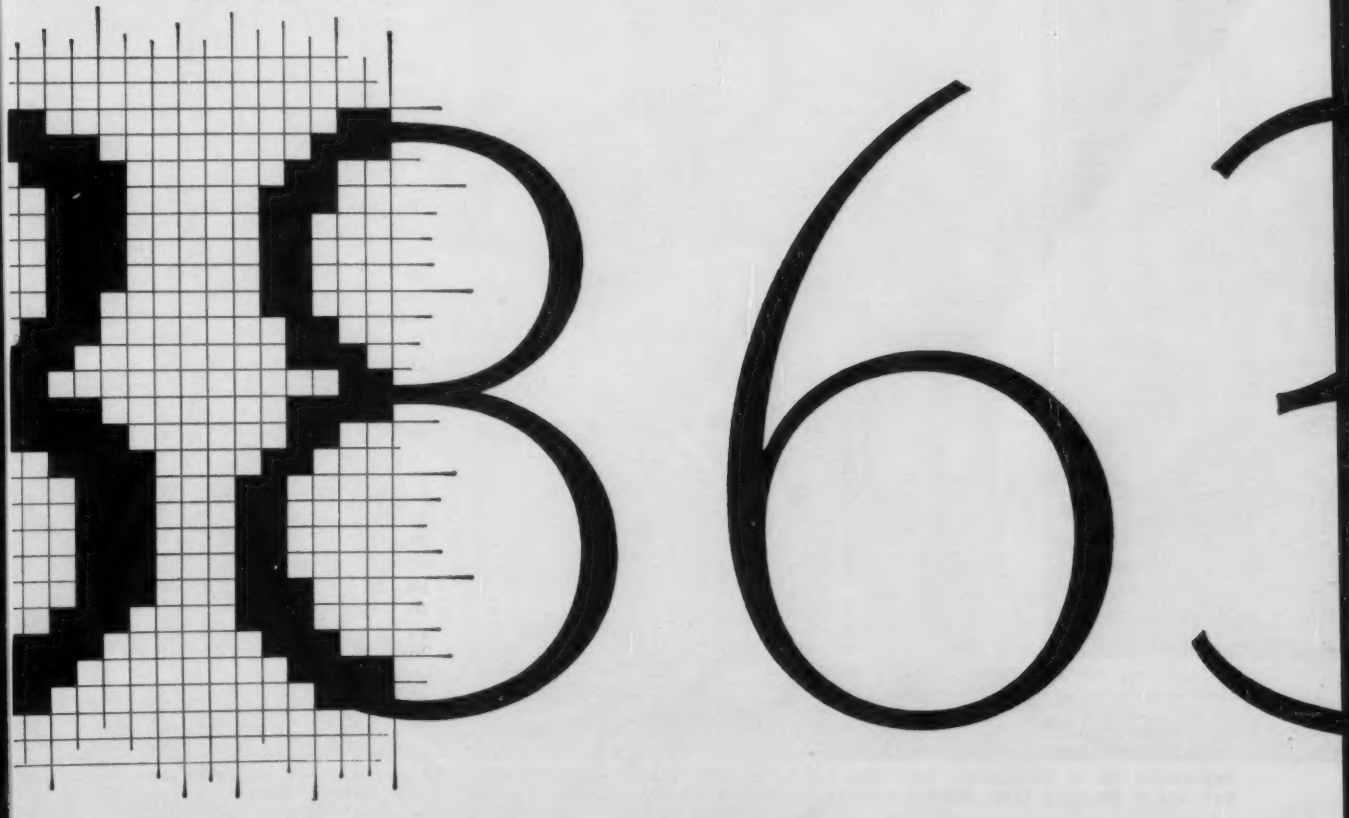

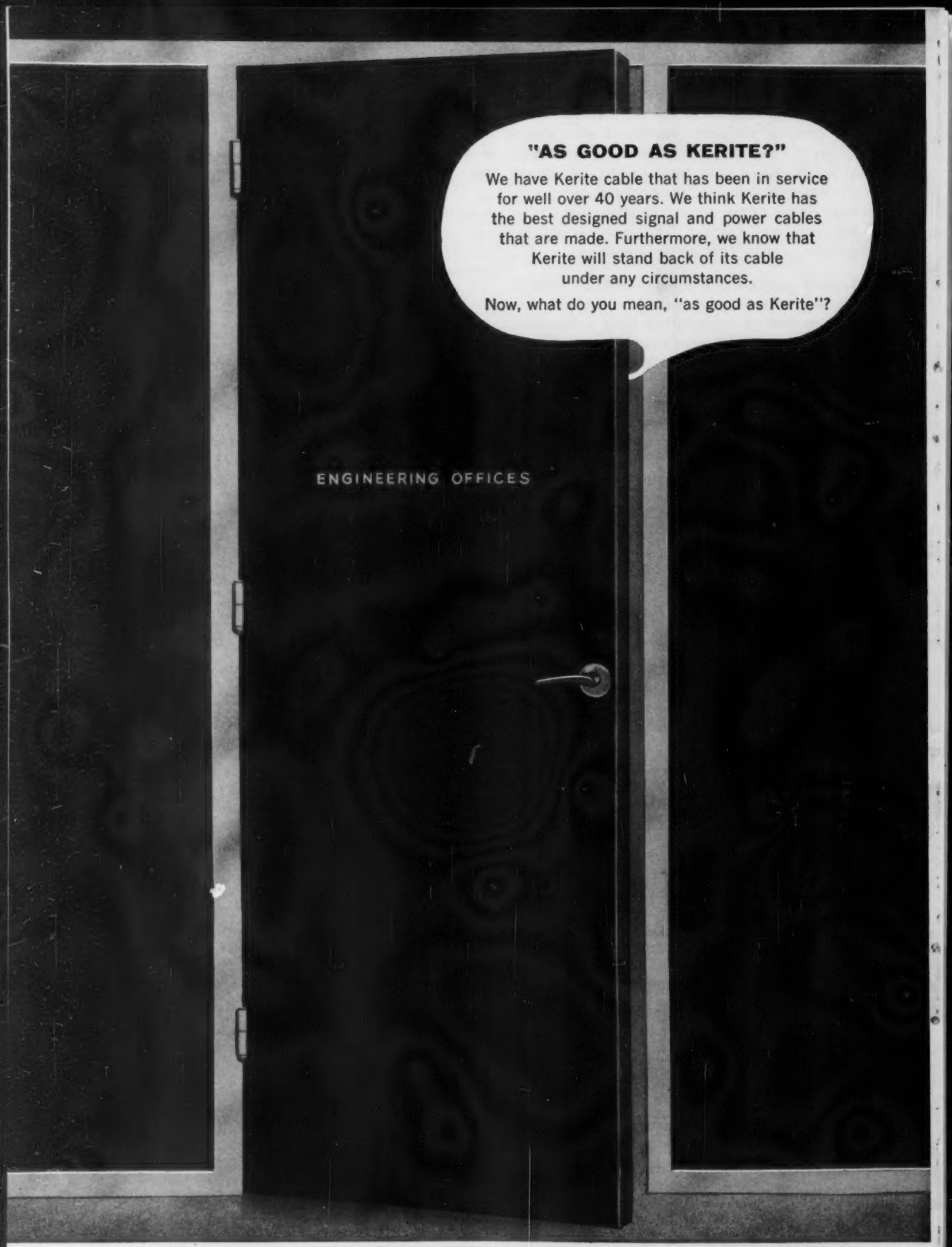
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SAA3507/1963

Acme ACME Electric
TRANSFORMERS

EE Leading engineering firm located in midtown Manhattan but relocating soon to Bergen County, New Jersey, seeks an EE with 3 to 5 years experience in designing automatic control circuits for processes or chemical industries. Work will involve supervision of drafting group.

Send resume and salary requirements to:

PERMUTIT COMPANY

A Division of Pfaudler Permutit, Inc.

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DESIGN ENGINEER

Minimum BSEE to work as Motor Designer doing scratch calculations for electrical portion of canned motor pumps. Must be experienced with AC Induction Motors in medium horsepower range. Knowledge of materials and fabrication methods desirable. *For prompt reply please forward resume (including salary requirements in confidence to: Mr. John Baker, Industrial Relations Department*

Westinghouse *ATOMIC EQUIPMENT DEPT.*

Cheswick, Pennsylvania

An Equal Opportunity Employer

Senior Engineer

Experienced in electrical design of hydro electric power plants.

Liberal relocation allowances. Send resume outlining experience and including your present and required salary to William A. Anderson, Technical Recruiting.

BECHTEL **Bechtel Corporation**

220 Montgomery Street San Francisco, Calif.

INTERESTED IN THE APPLICATION AND PROTECTION OF PILOT-WIRE CIRCUITS FOR PROTECTIVE RELAYING?

Selected fundamental reference articles on this subject are grouped and available in publication S-117.
Sponsored by the Pilot Wire Subcommittee of the AIEE Relays Committee, the special publication provides a handy reference for both utility and communications engineers working in this field.
Send $1.50 and specify S-117 to

Order Department
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
345 E. 47th Street, New York, New York

FROM THE GENERAL ELECTRIC COMPANY

6 answers—with some long-range meaning for Engineering Writers

Q Is this message published in an effort to hire Engineering Writers? If so, does it also include Technical Writers?

A **Yes, General Electric has openings for professional Engineering Writers in its Heavy Military Electronics Department. Most of these are new openings, based on Department growth. But while inquiries from Technical Writers would be welcome, these particular openings are for Engineering Writers only.**

Q So there is no misunderstanding, will you pinpoint the difference between the Engineering Writer and the Technical Writer in your organization?

A **It is in the degree of technical competence required. In our organization, the Engineering Writer is a professional in the full sense of the word—with a technical competence approaching that of the Design Engineer with whom he so closely works. HMED's Engineering Writers either have their BSEE's or the equivalent in experience and training.**

Q What is the nature of the work?

A **If qualified, you'll be assigned to one of the major electronic systems programs for which the Department is responsible. For example, you might be assigned to the Navy SQS-26 program—involving the most powerful shipborne sonar in the free world. Or it could be to a project designed to monitor all activity in millions of cubic miles of ocean. And these are but two . . . .**

Q What functions are involved?

A **You'll be providing the first "translation" of the raw material (i.e. graphs, schematics, charts, etc.) produced by the Design Engineer into manuscript form. From your manuscript and under your direction, support personnel provide publications covering systems philosophy, installation, operation, and maintenance for use by military customers.**

Technical competence is the vital qualification here. Certainly your writing talent is valuable, but in terms of major electronic systems—we need your technical competence. That's why even though you have responsibility from start to printed material, your support personnel take care of finished writing, illustrating, and printing.

Q What are the qualifications?

A **You could be qualified in either of two ways:**

1. If you have your BSEE and experience in our product line, you are probably qualified.

2. But we would also strongly consider an E.C.P.D.—accredited Technical School graduate or a man with two or more years' credit toward his BSEE. But in this case, you must have also had the following military experience:

2 or more years' maintenance or repair of major electronic systems, specifically radar (land-based or shipborne), computers (fire control or GCI), or sonar.

Q Assuming I qualify, would it really be worth a job change?

A **Yes—if you are looking for greater professional opportunity. In the first place, you'll be treated (and expected to contribute) at a high level. Also, you'll be joining an organization within G.E. that continues to grow. The technical writing staff has grown by 700% in the last eight years and there is no let-up in sight. Obviously, this means you are joining a Department that needs your talent—and the need will continue into the foreseeable future.**

More information about General Electric's extensive benefits program is available upon request. Relocation assistance will be provided. Qualified personnel will be invited to Syracuse for interviews at Company expense. All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin. 178-01

FOR MORE INFORMATION, *send a summary of your background and experience in confidence to:*

Mr. George B. Callender
Engineering Administration, Section T-7
Heavy Military Electronics Department
General Electric Company
Court Street, Syracuse, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Trade Literature . . .

High Voltage Components . . .

A new 16-page catalog and applications manual covers a complete line of high-voltage components and equipment and provides information on anti-corona terminations, high-voltage d-c supplies, encapsulated power packs, and high-voltage meters. Extensive technical data on the application of these products is included. Free copies are available from *Universal Voltronics Corporation, 17 S. Lexington Ave., White Plains, N. Y.*

Magnetic Drives . . .

Bulletin *3650* on magnetic adjustable speed drives describes in detail the basic components of the magnetic drive, theory of operation, controls, and design features. Some of the features of the unit include stationary field coil construction, liquid or air-cooled clutch system and an a-c tachometer generator. Controls supplied for the drive are available in the standard electronic controller as well as the optional transistorized controller. Write *Department P, The Louis Allis Company, 427 E. Stewart, Milwaukee, Wis.*

Digital Data System . . .

Bulletin *7110* gives complete information on a digital recording system for measurement of important variables such as voltage, demand, wattage, var, and temperature quantities at remote electric utility substations and telemetering of information in digital form to central recording station. The 2-page bulletin includes illustration, block diagram, and specifications of data system. For free copy, write *Monitor Systems, Inc., Dept. 31, Fort Washington Industrial Park, Fort Washington, Pa.*

Coupling Capacitors . . .

Two 8-page color bulletins describe the company's coupling capacitors and coupling capacitor potential devices. *GEA-7232* covering the capacitors, is heavily illustrated with photographs and diagrams and shows the proved economy, exceptionally long life, mechanical strength, versatility and reliability of coupling capacitors; also illustrated, *GEA-7233* gives a full description of coupling capacitor potential devices, which provide a low-cost source of potential for operating relays and instruments from high-voltage circuits. Both bulletins are available from *General Electric Communication Products Department, P. O. Box 4197, Lynchburg, Va.*

Neutrons . . .

A 4-page folder titled "Neutrons from Small Tubes," gives design data on tubes which provide neutrons in quantities intermediate to those available from isotopic sources and reactors. The text describes main features, ion source, accelerating system, replenisher, target assembly, neutron yield, and general performance of the neutron generator tube. The folder is illustrated with photos and drawings. Tube construction is shown in cross-section, Penning source principle is diagrammed, and a curve gives the relationship between accelerating energy and neutron yield. Available from *Philips Electronic Instruments, 750 S. Fulton Ave., Mount Vernon, N. Y.*

Ultraminiature Resistors . . .

Technical bulletin *P5 5/61* describes the company's new line of ultraminiature encapsulated wire-wound resistors for microminiature circuitry applications in industry and the military. The resistors consist of both the axial and lug types and range in size from .063 inch in diameter and .063 inch in length to $\frac{1}{2}$ by $\frac{1}{4}$ by $\frac{1}{8}$ inch. The units are available in maximum ohmic values from 200 K to two megohms and power ratings of up to 0.250 watt. The wire-wound resistors are operable in a temperature range between —65 and 125 C, with a maximum operating temperature of 150 C. *Reon Resistor Corp., 155 Saw Mill River Road, Yonkers, N. Y.*

Unit Mechanization . . .

An approach to automation based upon "unit mechanization" of specific or related work functions, rather than the fully automatic production line concept, is described and illustrated in a new 12-page brochure. Included are typical examples of special automated machines which are designed and built at relatively low cost to perform various manufacturing, inspection, assembly, and testing operations on parts and components now being produced for use by the automotive, aircraft, appliance, electrical, and hardware industries. According to the company's engineers, the principles and mechanisms for utilizing power to do desired work automatically can be applied to all types of production processes. Copies of the "Unit Mechanization" brochure may be obtained from *Jered Equipment Co., 1300 S. Coolidge Rd., Birmingham, Mich.*

Silicon Transistors . . .

A comparative study of high-frequency silicon transistors produced by four major manufacturers, has been published in a 28-page Designers Handbook by Raytheon Company's Semiconductor Division. Basis of the study was the *2N338*, its family of high-frequency silicon units, and their equivalent types in subminiature, single and double-ended packages. The lines of each manufacturer are described and compared for electrical and mechanical characteristics, parameter distributions, design requirements and other varying areas. The complete analysis is illustrated with charts, graphs, cross-sectional drawings and schematics. A free copy of the handbook may be obtained with a letterhead request to *Raytheon Co., Semiconductor Div., 150 California St., Newton, Mass.*

Digital Instruments . . .

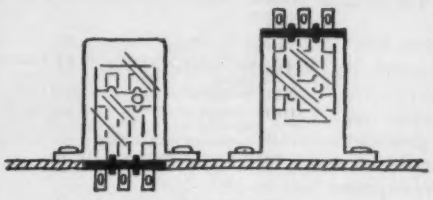
A new full-line 2-color, 20-page catalog, complete with price information and location of representatives describes the company's high-speed solid-state and vacuum-tube electronic counters, timers, preset counter controllers, decade-counting units, readouts, printers, and frequency-measuring instrumentation. For a free copy, address *Computer Measurements Company, 12970 Bradley Ave., San Fernando, Calif.*

Pointer Indicator/Controller . . .

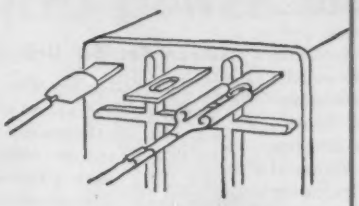
Comprehensive information on its type *110 SR-4* pointer indicator and indicating controller is furnished in the company's 6-page, 2-color bulletin, which provides an extensive summary on features, applications, accuracy, and controls; a 2-page graphic selection chart; sample application system sketches; specifications tables; and dimensions and connection details. Compact and versatile, the type *110* unit was developed primarily for use in measuring and control systems which employ strain gage transducers. Typical applications include weight and load measuring, pressure systems, and torque and horsepower measuring in a wide variety of industrial production and processing operations. Copies of the bulletin, *No. 4411*, may be obtained by inquiry to *Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass.*

(Continued on page 44A)

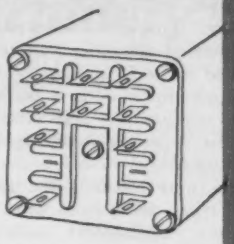
FRESH IDEAS IN RELAYS...



CHOICE of below-chassis or above-chassis connecting in plastic enclosures.



MULTI-USE terminals allow soldering, insertion in printed circuit board, and use of AMP Style 110 push-on terminals.



ALL TERMINALS on *one* panel... permits insertion in printed circuit board.

SPECIFICATIONS

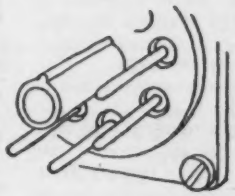
CONTACTS: *Integral with terminals;* up to 3PDT; 5 amp, 115 VAC or 32 VDC. Stationary contacts, fine silver inlay material; movable, solid fine silver.

COILS: Up to 230 VAC at 60 cps or 115 VDC.

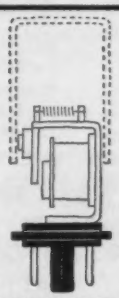
ENCLOSURES: Clear plastic.

TERMINAL PANELS: Barrier type or octal plug.

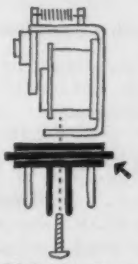
LATCHING RELAY: Available enclosed in clear plastic with plug-in mounting; or unenclosed.



OCTAL PLUG relays up to DPDT have recessed pin bases . . . meet UL spacing requirements to 150 V.



ALL ENCLOSED relays mount solidly on base . . . *not* on covers.



INTEGRAL plug-in base up to DPDT avoids wiring between contact terminals and pins.

OHMITE'S New "GR" Series

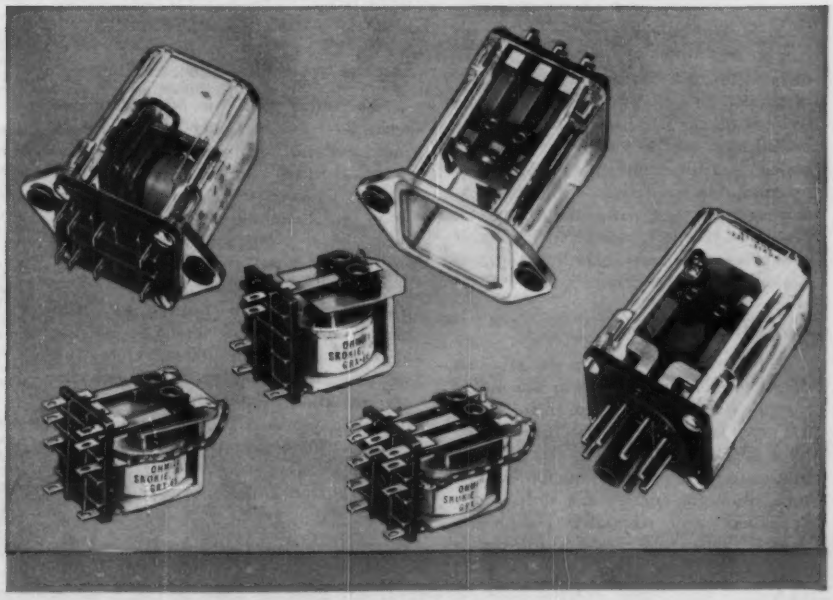
Stocked for Immediate Delivery From Distributors or Factory...

WRITE FOR BULLETIN 166

OHMITE

OHMITE MANUFACTURING COMPANY
3614 Howard Street
Skokie, Illinois

Rheostats • Power Resistors
Precision Resistors
Variable Transformers
Tantalum Capacitors • Tap Switches
Micromodules • Relays
R.F. Chokes • Germanium Diodes



(Continued from page 42A)

Accumulator Guide . . .

Hydraulic accumulators, their operating principles, designs, and uses are described in a new edition of "Guide to Hydro-Pneumatic Accumulators." This is the third edition of the illustrated reference manual first published in 1951. Completely revised and brought up to date, it includes missile age applications and recent developments in accumulator design. It contains a history of accumulator development, and details of the operations of all types of accumulators including piston, mechanical bellows, spring loaded, aircraft, and bladder types. Eight basic circuits utilizing accumulators are also illustrated. Free copies are available from *Greer Hydraulics, Inc., 5930 West Jefferson Blvd., Los Angeles 16, Calif.*

Aluminum Conductors . . .

New data on conductors, core wires, cable reels, and conductor lengths have been incorporated into a revision of *Aluminum Electrical Conductors, Stranded-Bare*. The publication includes information on 5,005 aluminum alloy conductors, aluminized steel core wire for ACSR (aluminum conductor, steel-reinforced), and details on a new size of expanded ACSR of 2,294 MCM, and 2.32-inch diameter. Separate physical characteristics and packaging tables for ACSR and stranded aluminum conductors are presented, and conductor cross-section diagrams, and reel and coil data included. *Rome Cable Div., Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.*

Electronic Transformers . . .

Electronic Transformers for Military Applications—GEA-7121, describes features and advantages of the company's full line of electronic transformers for military applications. This illustrated 28-page publication contains sections on the company's stock models including: metal-cased, hermetically sealed transformers and inductors, sipermil (encapsulated), and subminiature and microminiature transformers. Charts of model numbers, ratings, and case dimensions are included. *General Electric Co., Schenectady 5, N. Y.*

Transistor Amplifiers . . .

This technical bulletin describes in detail four 4-stage transistor amplifiers ranging in power output from 0.5 to 3.0 mw. They vary in size from 1 7/16 by 1 1/8 by 19/32 inches for the 3.0-mw unit to 1/2-inch diameter by 1/4-inch thick for the 0.5-mw unit. Units described are standard production models that can be modified to provide different frequency curves. Complete data on these amplifiers, including frequency response curves, noise level, load output, etc., are given in bulletin *42-1018* which is available from *Centralab, The Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.*

Silicon-Rectifier Unit . . .

This 4-page brochure describes the company's new silicon-rectifier conversion-unit for electrostatic precipitators. It tells how silicon rectifiers provide at least 25% more efficient rectification than mechanical rectifiers, and explains how conversion unit cost, low installation cost, and virtually no maintenance costs save money for the user. The brochure further explains how the silicon rectifier is installed without replacing any equipment other than the old rectifier, and how it connects to the existing high-voltage conductor and transformer terminals. *Buell Engineering Company, Inc., 123 William St., New York, N. Y.*

D-C Amplifier . . .

The company is offering new technical literature on its all-solid-state differential operational amplifier *Model A-2*—for use in analog computing and complex data-handling and process control applications—and power booster *Model G-2* for use with the A-2 in driving heavy instrument systems, small d-c servos, and rotary amplifiers. Complete electrical and mechanical specifications are presented, together with price information, application schematics and oscilloscope photos showing common mode operation and unity gain waveform reproduction. Request Bulletins *No. 031* and *No. 032* from *Ridgefield Instrument Group, P.O. Box 337, Ridgefield, Conn.*

Logic Circuit Plug-Ins . . .

Technical Bulletin *60-E* describes series *2010* 200-kc Logix Blocks, a complete and fully compatible set of transistor-operated digital logic circuit plug-in modules for rapid, low-cost design and assembly of special purpose digital computers, data-processing equipment, digital communication links and magnetic storage equipment. The illustrated bulletin points out that these plug-ins are designed to operate at data rates in the 200-kc range, and include flip-flops, gates, amplifiers, inverters, and pulse generators, providing the systems designer with a full complement of inexpensive basic logic elements. *Rese Engineering, Inc., A and Courtland Sts., Philadelphia 20, Pa.*

(Continued on page 46A)

(Continued from page 30A)

ELECTRONICS DESIGN—CIRCUITS: $800-1,000, BSEE, in California, age 28-50. Must have minimum of five years high-level circuit design experience must be strong in theoretical design capability. Required to develop circuitry to meet specified performance characteristics with minimum of supervision. Knowledge of transistor circuitry mandatory, knowledge of tape recorder systems desirable. For a manufacturer. Sj-6060

PROJECT ENGINEER—ELECTRONICS: $9-12,000 plus, in Contra Costa County, EE. Five years industrial electronics experience including circuit design and project management. Must be fully experienced in the design of servo feedback control systems employing semi-conductors. For a manufacturer designer. Sj-6331

INSTRUMENTATION-CHEMICAL: salary is commensurate, in San Francisco North Bay, EE, ChE, age to 35. Recent graduate to fifteen years experience with process plants, consulting engineers or engineer-builders on engineering department or plant engineering of process control instrumentation in chemical, petro-chemical or petroleum plants. Will work in engineering services or plant engineering departments. For a chemical manufacturer. Sj-6079

SUPERVISOR, ELECTRICIAN-WIRING: about $1,000, in Guam, electrical engineering background, age open. Four to five years experience to supervise on wiring and related in line work, government installations. United States citizenship required. Transportation paid by employer. For a contractor. Sj-6349

DESIGNER—LIGHT AND POWER: salary commensurate, in San Francisco, EE plus EIT or license, age to 40. Minimum three years experience in consulting type office designing and board work on electrical wiring, power and distribution of industrial and commercial buildings. For a consultant. Sj-6293

INSPECTION, TEST-ELECTRONIC, ELECTRO MECHANICAL: salary open, EE, in California. Supervise activities of line inspection and test. Supervise and plan test equipment requirements and construction. Establish test procedures and methods for inspection and test of complex electronic and electro mechanical assemblies. Must have ability to sell quality control requirements and standards to manufacturing personnel. Should have minimum of two years supervisory experience, five years experience in areas of testing test methods and quality control. For a manufacturer. Sj-6268

RESEARCH, DEVELOPMENT-MICRO WAVE TUBES: salary commensurate, in Santa Clara county, EE or MS, age young. Recent graduate or one to two years work. Definite aptitude for research and development, design microwave tubes, magnetics, strong on theory. For an established manufacturer. Sj-6256

DESIGN, DRFAT-ELECTRICAL: Salary depends on ability, in San Francisco. Two to three years experience in design and layout of lighting and power systems for commercial and industrial buildings (schools, churches, warehouses, process plants and control). For a consulting electrical engineer. Sj-6255

DESIGNER-ELECTRICAL: $500-750, in San Francisco, EE, age young. Recent graduate to a few years experience relating to industrial, commercial or public primary and secondary electrical power distribution and usage. Able to work with code and special requirements, and participate from planning through final plans. For a consultant. Sj-6252

APPLICATIONS, DESIGN - ELECTRICAL DRIVES: $700, in San Francisco, EE, age young. Some experience in electrical variable speed drives, capable of assisting in the selection and specification of direct current motors controls, power transmission and related equipment for large, heavy powered paper and pulp machinery. For a manufacturers central engineering division. Sj-6092

at PRATT & WHITNEY AIRCRAFT ...
• advanced technology in electrical power machinery

The challenges of space missions and other advanced power applications demand the ultimate in electrical machinery technology. Pratt & Whitney Aircraft is conducting applied research and development in the field of advanced electrical machines. For example, included in the range of current investigations are cryogenic applications, and liquid metal cooled, high temperature, high speed machines.

Currently, Pratt & Whitney Aircraft has career openings at all levels of experience for electrical engineers interested in advancing generator and motor technology in the space environment and other unusual applications.

These positions are now available:

ELECTRICAL ENGINEERS: BS, MS, or PhD, at all levels of experience are required for the following programs: design and development of high speed AC or DC motors and generators; research and development of low and high temperature conductors, insulators and magnetic materials.

For the engineer seeking an ideal environment, Hartford, located midway between Boston and New York, provides all types of cultural diversions and competitive sports. Year-round recreation abounds at both seashore and mountains—with swimming, hunting, skiing, camping and fishing within easy reach.

Please submit your resume, including minimum salary requirements, to:
MR. P. R. SMITH, OFFICE 66
All replies will be handled promptly and in complete confidence.

PRATT & WHITNEY AIRCRAFT
DIVISION OF UNITED AIRCRAFT CORPORATION
EAST HARTFORD 8, CONNECTICUT

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Challenge in Missilery for

Electronics Engineers

Now in the initial stage of a long range program in product engineering and program management for re-entry vehicles, components and GSE, Lycoming offers a broad spectrum of opportunities.

Immediate assignments for qualified BSEE's with experience in the following areas.

Electronics Engineers

- *Instrumentation, calibration, laboratory techniques, model fabrication. Knowledge of military equipment desired. 3 years' experience.*
- *SHF & VHF antennae for missiles. Telemetry knowledge desired. 3 years' experience.*
- *Background in telemetry for military missiles. 3 years' experience.*
- *Field engineering on military GSE. Some design or manufacturing knowledge desired. Moderate travel. 5 years' experience.*
- *Electronic product engineering — must be familiar with military designs, techniques, design change order procedures, proposals and specifications. 2 years' experience.*

Sr. Project Engineer - Electronics

Strong varied background in military electronics project direction in areas of missiles, GSE, design, manufacturing and test. 10 years' experience.

Sr. Electronics Engineer

- *Military electronics — design and development of missiles components such as antennae, telemetry circuits and UHF equipment. 5 years' experience.*
- *Feedback control systems, transistor amplifiers, servo analysis and military electronics design. 5 years' experience.*
- *Background in automatic checkout equipment for military use. 5 years' experience.*

Successful applicants will be working for Chester A. Sandner, Chief Electronic Engineer.

Send complete resume including salary requirements to Mr. Harry A. Stone

Lycoming
STRATFORD, CONN.

Division of AVCO Corporation

All qualified applicants will be considered regardless of race, creed, color or national origin.

Symposium on Research and Education

Special Publication S-82 comprises of four papers that were presented at the AIEE Winter General Meeting, New York, N. Y., February 2, 1956, and is sponsored by the AIEE Committee on Research and Education. The papers deal mainly with the problems of the utilities and the industry in general in attracting young engineers into the field.

The price is $1.60 ($0.80 to AIEE members). Available from:

Order Department

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

345 E. 47th St.,
New York, N. Y.

Electrical Engineers

Opportunities for research and development in areas of semiconductors, plasmas, and ferromagnetic materials. Experience and/or advanced degree desirable. For further information write, briefly stating your background and experience, to

Mr. J. T. Jarman
Research Division
Allis-Chalmers Manufacturing Company
Milwaukee, Wisconsin

(Continued from page 44A)

Potentiometers . . .

"Fairchild Single-Turn Wirewound Potentiometers," a 6-page illustrated brochure describes the company's line of linear, nonlinear and sine-cosine precision potentiometers. The brochure contains performance data on 11 models of the potentiometer line and an explanatory section which describes the special features of the line in detail. Also included are photographs, cutaway views and outline drawings of the units. Copies are available from *Fairchild Controls Corporation, 225 Park Ave., Hicksville, L. I., N. Y.*

Air Conditioner Fact File . . .

The Airflow line contains four basic series of air-conditioning units: MAC Series, designed for use under severe operating conditions, engineered to conform with all military specification requirements; SAC Series, a less expensive version of the MAC Series; TRAC Series, mobile 2-wheel trailer-mounted air-conditioning units specially designed for flexibility and easy transportation—trailers are built to ordnance or commercial specifications; and APU Series designed particularly for aircraft use, extremely lightweight, engineered for operation on 400-cycle or d-c electric systems. The *Fact File* will be sent free of charge by *Airflow Company, 400 S. Stonestreet, Rockville, Md.*

Infrared Equipment . . .

A brochure describes new techniques which use fluid cooling, making possible very compact quartz lamp ovens and furnaces with extremely high heat transfer rates. Additional features claimed for this new equipment are precision control with no contamination during processing. Almost any shape of equipment may be fabricated to meet nearly any requirement for high temperatures up to 3,000 F or for short cycles. Copy of the brochure available on request from *Fostoria Corp., Dept. 102, 1200 N. Main St., Fostoria, Ohio.*

Subminiature Potentiometers . . .

A 2-page bulletin describes the company's *027* Series of subminiature slide wire trimming potentiometers and variable resistors. The bulletin includes basic circuit schematics and a cutaway view showing the structure of this series. Electrical, environmental and mechanical specifications are detailed, and a curve of temperature versus wattage is given. Write to *Con-Elco Div., Edcliff Instruments 1711 So. Mountain Ave., Monrovia, Calif.*

Control & Torque Synchros . . .

To aid in the rapid and correct selection of size *11* 400-cycle Thru-bore control and torque synchros for servo applications, the company's new data sheet *CS/TS-4-11-1* is now available. More than 25 typical characteristics are charted for transformers, transmitters, differential transmitters, and receiver transmitters. Schematic drawings, with dimensions, show body terminal block spline and other data. Wiring diagrams and terminal designations are also included. All military units are engineered and manufactured to *MIL-S-20708A* specifications, others are of Vernitron standard design with windings and shafts modified to individual customer requirements. For copies write to *Vernitron Corp., 125 Old Country Rd., Carle Place, L.I., N. Y.*

Selenium Rectifiers . . .

A new bulletin gives electrical and mechanical specifications of the company's full line of certified selenium cells and stacks, and of its cartridge-type selenium rectifiers in tabular form. Illustrated in color, bulletin *400* includes cutaway drawings showing features of its selenium rectifiers contributing to Syntron's exclusive semiconductor certification and guarantee policy. Details of the company's vacuum vapor deposition process are revealed in the drawings, as well as construction features of a typical Syntron selenium stack assembly and its "selenium slim" cartridge rectifiers. Typical operating characteristics of the rectifiers are shown in curves displaying forward current rating levels and derating curves for raised ambient temperatures. Copies of the bulletin may be obtained by writing to the *Semiconductor Division, Syntron Company, Homer City, Pa.*

Tenite Polypropylene Formulas . . .

Electrical and physical properties of Tenite polypropylene formulas developed for solid and cellular coatings of wire are described in Technical Report No. 7. The report, detailing typical extrusion conditions for both types of coating, also presents comprehensive information, accompanied by diagrams, on techniques for applying the plastic material to wire and the equipment required. The high-dielectric strength of solid Tenite polypropylene, which has excellent surface hardness and good resistance to abrasion, permits the use of thin coatings and heightens the latitude for running multiple wires through conduits and jackets. The report is available on request from the *Plastics Div., Eastman Chemical Products, Inc., Kingsport, Tenn.*

(Continued on page 47A)

(Continued from page 46A)

Steel Design . . .

Four papers which discuss continuing advances in the strength levels, product forms, and design applications of constructional steels are printed in a 59-page brochure, "New Concepts in Steel Design and Engineering." The papers describe and compare the types of steels that make up the modern "family" of constructional steels. Illustrations and descriptions of many actual designs and design concepts show how these steels can be used in structures and equipment to achieve higher strength, lighter weight, and lower costs. For a free copy of the brochure, write to: *Market Development Div., U. S. Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.*

Micrologic Elements . . .

This 2-color 8-page brochure announces the first of a series of Micrologic elements developed by the company. Now available is the Micrologic flip-flop, the first member of a family of six digital functional blocks which together can be used to build the complete logic section of a digital computer, The brochure describes applications and logic design with the Micrologic flip-flop in addition to providing diagrammatic drawings of the five other elements, all of which operate over the full military environment at bit rates above 1 mc. *Fairchild Semiconductor Corp., 545 Whisman Rd., Mountain View, Calif.*

D-C Power Supplies . . .

This catalog provides complete data on more than 150 standard models of the company's line of regulated d-c power supplies, including semiconductor, vacuum tube, magnetic, and hybrid designs. It features 32 pages including three design groups: "SM," "HB," "PR" models; separate listing and description of programmable current/voltage regulated models; special nomograph of voltage drop vs. wire size and supply current; dual index to all models both by design group and by output voltage. *Kepco, Inc., 131-38 Sanford Ave., Flushing 52, N. Y.*

Flexible Coaxial Cable Catalog . . .

This 16-page catalog on HELIAX, the flexible air-dielectric cable, describes in detail the improved electrical and mechanical characteristics of HELIAX and accessories now available in 50, 75, and 100 ohms and in a range of sizes from ⅜ inch to 3⅛ inches. For information write for Catalog H, *Andrew Corporation, P.O. Box 807, Chicago 42, Ill.*

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It takes modern equipment plus craftsmanship and know-how to produce fabrications such as the giant generator housing shown here—illustrative of Kirk & Blum's ability to produce the unusual as well as the conventional types of weldments. In its 170,000 sq. ft. plant, with crane capacity to 25 tons, Kirk & Blum has complete facilities to produce, preassemble and finish a wide variety of carbon steel, stainless, aluminum, monel and other alloys assemblies up to ½" thickness. Fifty years of exceptionally varied experience is your added assurance that the job will be done quickly and economically.

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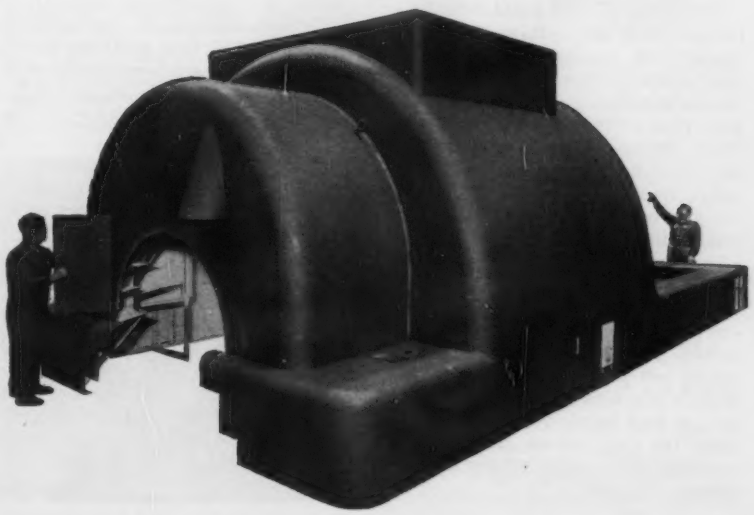


Industrial Notes...

General Precision Inc.
Binghamton, N. Y. . .

A new and extremely accurate flight simulator, manufactured by the Link Division, General Precision, Inc., Binghamton, N. Y. and Palo Alto, Calif., has been accepted by the Navy to be used at the Moffett Field Naval

Air Station as a training device for the Navy's F8U-2N Crusader Jet Aircraft. The Crusader Flight Simulator is officially called Device *2F72*, the *F8U-2N* Weapons Systems Trainer. It is housed in two large specially designed trailers, one trailer contains the flight simulation and the other the tactics simulation. The Trainer was developed to provide pilots with safe, effective, and controlled training in flight operations, instrument applications, emergency procedures and tactical procedures. This Weapons System Trainer makes possible the "flying" of entire simulated missions.

Allis-Chalmers
Milwaukee, Wis. . .

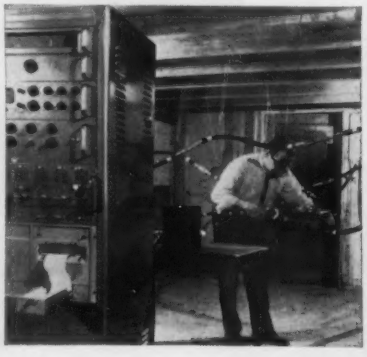
The company will build three Francis-type hydraulic turbines with governors and pressure regulators and three umbrella-type synchronous generators with excitation systems and indoor type air housings for the Round Butte Hydroelectric Development of the Portland General Electric Company, Portland, Oreg. The turbines are guaranteed to develop 115,000 hp each at 180 rpm under a 315-foot head; when the head of water rises to a predicted peak of 355 feet, they will each develop 140,000 hp. Each unit will be set vertically in a field and shop welded plate steel spiral case measuring 12 feet 9 inches in diameter at the inlet. The generators, rated 91,500 kva, 90% power factor, 82,350 kw, 13,800 volts, 180 rpm, will be installed in an enclosing air housing having a 40-foot outside diameter.

IBM
New York . . .

One of the most powerful computers in the world, the *IBM 7090*, comprising more than 17 tons of high-speed data processing equipment, specially designed for scientific and engineering problems, has been sent to the Ispra Atomic Research Center at Lake Maggiore in Italy. It will be the focus of all the nuclear work being done by EURATOM, the European Atomic Energy Community. One of the computer's most important functions will be to perform as an "electronic library." Scientists feel a great need for this, as every year well over a million technical journals are published throughout the world in a multitude of languages. Work on the computer will be concentrated not only on cataloging this mountain of technical information, but also on actually translating the various publications.

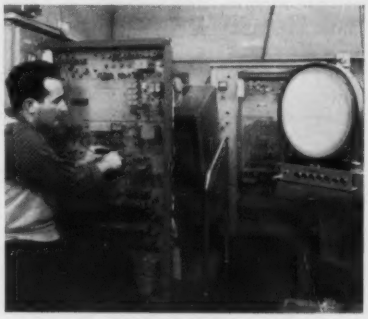
Thomas & Betts Co., Inc.
Elizabeth, N. J. . .

Electronically controlled digital volt meter plays vital role in special current cycling chamber at expanded research and development laboratories of the company where the performance of electrical and electronic connectors and fittings is determined. New instrument makes test facility fully automatic, eliminates former need for manual checking which is demonstrated here by laboratory technician using a hand pyrometer to record temperature of the connectors. The temperature of the connector and conductor, as well as the current in the test assembly, now can be automatically recorded, and transcribed to tape for later analysis. Actual test shown here compares performance of wrought aluminum with cast aluminum connectors.



Intercontinental Electronics
Westbury, N. Y. . .

The company has delivered a complete scan conversion installation for air traffic use to the Federal Aviation Agency Radar Approach Control Facility at Edwards Air Force Base, Calif. The equipment will be operated by the



agency's Air Traffic Service for the important Palmdale air traffic complex. Known as the INTEC scan conversion or radar bright display system it takes electrical information from radars in the Palmdale area, changes its electronic form, and presents it as a bright, controllable television picture for use in air traffic control.

Burroughs Corp.
Detroit, Mich. . .

The company has delivered to the U. S. Navy an ultraminiaturized electronic 3-cubic-foot air-borne digital computing system which has the same computational ability as a conventional room-size computer. Weighing less than 190 pounds, the system designated as the Burroughs *D-202* may also be easily adapted as the central computer for a manned space vehicle or as an air-borne prelaunch computer for air-to-ground missiles. The high-capacity computer employs silicon transistorized circuitry, proven components, and an advanced design and packaging technique to assure high reliability under extreme environmental conditions, both for present and future needs. High packaging density is achieved through the use of rugged, replaceable circuit modules, called "Logi-Mods," averaging 19 electronic components encapsulated in a volume of ¼ cubic inch. Extensive input-output equipment, housed separately to simplify modification for other applications, enhances the system's versatility.

(Continued on page 49A)

(Continued from page 48A)

Franklin Institute Philadelphia, Pa. . .

Officials of The Franklin Institute Laboratories for Research and Development have announced the creation of an Aerospace Laboratory. The new laboratory, part of the organization's mechanical and nuclear engineering division, will be responsible for engineering projects dealing with air and space vehicles, and with simulators and other special research equipment needed in the nation's space program. As manager of the Aerospace Laboratory, Klaus L. Cappel will head a staff of mechanical engineers and designers which will be augmented as needed from the staff of 300 physicists, chemists, mathematicians, and electronics specialists working in other Institute laboratories. The new laboratory will continue work on two of the Institute's current space programs: design of a satellite, and design and construction of a new simulator for testing human tolerance of certain types of acceleration.

Midwest Research Institute Kansas City, Mo. . .

A center for the study of developments in germanium technology and for the encouragement of germanium research, has been organized at Midwest Research Institute. To be known as the Germanium Information Center, the activity is unique in this country. Its formation is being sponsored by the Germanium Research Committee, which includes representatives of several U.S. and foreign mining corporations. The sponsors include American Zinc Lead and Smelting Company of St. Louis, Mo.; the Eagle-Pitcher Company of Cincinnati, Ohio; Societe de la Vieille Montagne of Angleur, Belgium; Tsumeb Corporation, Ltd., of New York; and Union Miniere du Haut-Katanga of Brussels, Belgium.

Dunn Engineering Corporation Cambridge, Mass. . .

The company, manufacturer of electronic systems and inertial guidance and other missile test instruments, has established a digital systems department to develop advanced digital techniques for checkout of guidance equipment and in automatic control of industrial processes. The new department will develop systems for the company's own instruments, used in precision testing of gyroscopes, accelerometers and other sophisticated electronic equipment such as is found in the inertial guidance systems of space vehicles and missiles.

(Continued on page 50A)

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HERE'S HOW... with a GLENN PACIFIC power supply, you can convert your existing single, two or three-phase ac line power into:

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LINE COMPENSATION VOLTAGE REGULATOR for radar station accepts 3-phase, 208v ±10%, delivers 3-phase 208v ±1% at 300 amp., with non-distorted sine wave at all settings. Rated at 108 kw, 100% duty cycle, convection cooled.

ELECTROLYTIC CAPACITOR FORMING power supply provides continuously-variable dc output from 0 to 415 volts, 300 amperes. Input is 230/460 v 3 phase. Other units available with 0-250 v output. Many of these GLENN PACIFIC units are used by leading capacitor manufacturers.

VARIABLE VOLTAGE transformer used in laboratory power supply delivers 0 to 460 v ac at 200 amperes; operates from 3 phase 208/230 v input.

WHAT'S YOUR PROBLEM? Need a dc source for motor drive and speed control—for powering laboratory or production line dc magnets, instruments, test stands—for electroplating, electrolytic refining, etching, de-tinning? You'll be hours and dollars ahead to contact GLENN PACIFIC; please address Dept. 135.

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United Engineers & Constructors Inc. has attractive openings for Electrical Engineers in the fields of power and heavy industrial facilities.

B.S. in E.E. required with two to six years experience in industry.

Full benefits, professional status, opportunity for advancement. Moving expenses to Philadelphia location. Send complete resume to A. C. Eckerman.

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Philadelphia 5, Pa.

LIGHTNING REFERENCE BIBLIOGRAPHY
1936-1949

Prepared by the AIEE Lightning and Insulator Subcommittee, this bibliography, S-37, contains 754 separate references on lightning and related topics published from January 1, 1936, to December 31, 1949, in most of the better known English, French, and German journals on electrical engineering or physics.

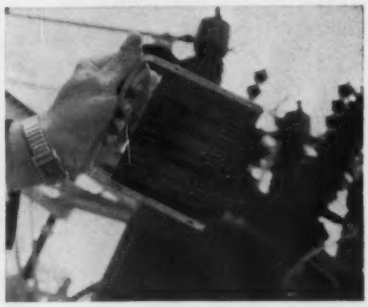
For easy reference, there is a Subject Section, subdivided into 18 classifications, and an Author Section, which contains a list of about 550 authors. Price: $0.70 ($0.35 to AIEE members).

Available from the Order Department, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 345 E. 47th St., New York, N.Y.

Continued from page 49A)

General Electric Company
Schenectady, N. Y. . .

The Western Massachusetts Electric Company has installed new control equipment providing remote-controlled power transmission to the entire Pitts-



field, Mass., area, as the first application of this equipment in the utility industry. The brain of this transistorized supervisory system is a plug-in logic element, which centrally controls the distribution of electricity to consumers served by three remote power stations in the western Massachusetts area. It also controls the power for General Electric's project Extra-High-Voltage in this area. The equipment was manufactured by the Medium Voltage Switchgear Department in Philadelphia.

Tenney Engineering
Union, N. J. . .

Moving into the field of industrial process controls, this company has developed a line of precisely regulated variable-speed drives featuring a unique electronic control. The drives, in both standard and custom-built models, have wide application in almost any industry where a rotating system is employed whose speed must be controlled. The standard line offers 0.5 to 2% regulation of set speed. Custom drives are available with regulation as precise as 0.1%.

Vitro Services
New York, N. Y. . .

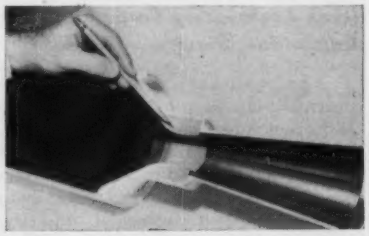
Vitro Weapons Services has changed its name to Vitro Services. The company is engaged in the installation, maintenance and operation of precision equipment and instrumentation. Technical activities include microwave communication links for railroads, pipelines and others; electronic computers, special telephone systems and environmental facilities with particular emphasis on test-range instrumentation for missiles and space probes.

Ampex Corporation
Redwood City, Calif. . .

This company has been awarded a $1,436,769.00 Navy Bureau of Ships contract for the production of 314 2-channel, 3-speed magnetic tape recorder/reproducers for the U. S. Navy. Designated the *AN/UNQ-7B*, the transistorized device is designed for continuous heavy-duty operation in both surface and undersea craft, and is especially well suited for measuring structure-borne noise and vibration in conformance with *MIL-STD-740*. The *AN/UNQ-7B* consists of two units, a recorder/reproducer, which provides simultaneous recording and playback on both channels, and a remote control unit capable of completely controlling all operational modes of the recorder/reproducer. Using ¼-inch tape on 7-inch reels, tape speeds of either 3-¾, 7-½, or 15 inches per second (ips) are available while recording and reproducing, with frequency response not varying more than 2 db over a frequency range of 50 to 20,000 cycles per second (cps) at 15 ips, 50 to 10,000 cps at 7-½ ips, and 50 to 5,000 cps at 3-¾ ips.

Hughes Aircraft Co.
Culver City, Calif. . .

The company has received a contract to develop new plastic materials and self-cooling techniques for missile exhaust nozzles that may make it possible to operate rocket engines at extreme temperatures of 10,000 F. The work will be done under a $124,000 contract from the Air Force's Aeronautical Systems Division. The new plastics are intended for advanced rocket motors and will be used to line the critical throat area and the entrance and exit sections of the nozzle. The new compound will be polymeric and composite (ceramic and refractory plus plastic) and will be formulated to



resist highly erosive and chemically reactive exhaust of advanced propellants. The plastics are expected to resist sonic and supersonic rocket exhaust velocities for periods of several minutes and to result in higher performance propulsion systems for aerospace craft.

(Continued on page 51A)

(Continued from page 50A)

General Instrument Corp.
Newark, N. J. . .

Expanding into a new area of electronic materials development, the corporation has established a special Ferro-Electric Ceramic Department at its Newark, N. J., headquarters plant and, using its own newly developed processes, has begun production of advanced types of piezo-electric ceramic materials and components for use in military and industrial electronic equipment. New products already developed include: ceramic semiconductors, which produce a thermoelectric effect; piezo-electric ceramics for transducers used in military underwater sound-detection systems and utrasonic cleaning; ceramic filter elements, which "filter out" unwanted frequencies in radar and communications systems; thermistors, or "heat switches" for temperature measurement; and a wide range of other piezo-electric ceramic devices for electronic instrumentation.

TRW Computers Co.
Los Angeles, Calif. . .

The company will supply the Tennessee Valley Authority with two digital computers to control its Paradise Station units 1 and 2 near Drakesboro, Ky. The system will automatically control the turbine generators, sequence monitor the steam generators, and sequence cold start, hot restart, normal shutdown, or emergency shutdown of the units. In addition, the system will perform sensor scanning and alarm monitoring, data logging, trend recording and performance calculations. The two units will produce a total of 1,300,000 kw of power, and will be the largest power-generating installations in the United States. The first unit is scheduled to begin operations in the fall of 1962, the second for mid-1963.

Datex Corp.
Monrovia, Calif. .

A digital data system that will read out and visually display angular displacement of the three axes of a direction-finding antenna to high accuracy is under construction by the company. The system, to be used by the Air Force in Alaska, is being built under a $22,000 subcontract from the Philco Corporation. The equipment will be capable of satisfactory operation over the ambient temperature range of −7 to +43 C and in relative humidity in excess of 98%. The system will be accurate to ±0.01 degree of actual azimuth axis position, and ±0.015 degree of actual declination and traverse axes positions.

(Continued on page 53A)

Control and Instrumentation Engineers

A key research and development program is now underway at Atomics International to design long-life, compact, lightweight nuclear reactors that will provide auxiliary power systems for space applications. Many interesting problems exist to challenge electrical engineers who want to relate their present experience to reactor technology in any of the following areas:

FLIGHT INSTRUMENTATION DESIGN

Electrical control system design and/or aircraft or missile flight instrumentation design. Will establish flight instrumentation requirements, block diagrams for flight and test systems, preliminary specifications for each instrument or subsystem.

TELEMETRY

Responsible engineers to analyze, plan and specify the telemetry required to ascertain the performance of nuclear power plants during space tests. The individuals must have experience in missile instrumentation and telemetry of temperature, vibration, acceleration, etc. BS or MSEE preferred.

CONTROL ANALYSIS

Dynamic and control analysis including system start-up and full power operation. BS or MSEE plus familiarity with latest analog and digital techniques required.

CIRCUIT DESIGN

Electronics engineers experienced with both vacuum tube and magnetic devices to design and develop control circuits for compact nuclear power plants.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

For specific details write: Mr. E. J.Newton, Personnel Office, Atomics International, 8900 DeSoto Avenue, Canoga Park, California.

ATOMICS INTERNATIONAL
DIVISION OF NORTH AMERICAN AVIATION

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Application of Incremental Heat Rates for Economic Dispatch of Power (July 1958)

This 52-page report summarizes the activities of the Working Group on Application of Incremental Heat Rates for Economic Dispatch of Power since it was organized in April 1956.

Included are six papers and a summary of round table discussions, valuable to the power industry, presented at the AIEE Fall General Meeting, October 10, 1957, in Chicago, Ill.

The price for publication S-104 is $3.00. Send to:

Order Department
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
345 E. 47th St. • New York, N. Y.

(Continued from page 514)

American Electric Power New York, N. Y. . .

Recently completed tests, jointly conducted by American Electric Power Service Corporation and S.&C. Electric Company, demonstrated the ability of S.&C. type G circuit switchers to interrupt fault currents within 5½ cycles, de-energize 125 miles of 138-kv line without restriking, and interrupt 130 mva in a 138-kv loop circuit without causing incorrect operation of carrier ground relays. The "circuit switcher" superficially resembles an ordinary gang-operated airbreak disconnect but has totally enclosed interrupters which operate integrally with the disconnect blades. Double gap type G interrupter units were used for line dropping and loop switching tests; single gap type for fault tests. All tests were conducted on the effectively grounded 138-kv system connected to Clinch River Plant of Appalachian Power Company.

Sola Electric Co. Elk Grove Village, Ill. . .

A custom-built power supply for Varian Associates that supplies regulated voltage to a Rubidium Vapor Frequency Standard or "atomic clock" has been built by the company. Uses for this instrument will be in synchronized time and frequency-control applications such as satellite tracking networks, navigational systems, and communication systems. The Sola constant voltage power supply will be used to operate the clock, which is equipped with a nickel-cadmium storage battery as a stand-by power source. The CV supply will normally provide all current required by the clock and in addition, supply a trickle charge to the battery. The supply is capable of continuous duty for several years.

Continental Electronics Mfg. Co. Dallas, Texas . . .

The company has received a contract to build a power supply for the Argonne National Laboratory's 12.5-billion-electron-volt proton synchrotron. The laboratory is operated for the Atomic Energy Commission by the University of Chicago. One of the world's most powerful nuclear research devices, the proton synchrotron will enable scientists to experiment with known atomic phenomena and to discover new phenomena occurring when high energy protons collide with other protons at rest. These collisions usually result in the production of rare, short-lived particles—some with a life span of 1/10,000th of a millionth of a second.

CLASSIFIED ADVERTISING

Regular classified advertisements set solid—no display—minimum 5 lines: $3.00 per line. No agency commission or cash discount allowed. Situation Wanted classified advertising for AIEE members: $2.00 per line, minimum 5 lines. Address orders to: Classified Section, ELECTRICAL ENGINEERING, 11th floor, 345 E. 47th St., New York 17, N. Y.

When answering an advertisement, send all replies to box number specified, c/o ELECTRICAL ENGINEERING, 11th floor, 345 E. 47th St., New York 17, N. Y.

POSITIONS OPEN

INSTRUCTORS, Associates, Assistants for teaching and research part-time position while working for M.S. and D.Sc. Large graduate program assures variety of offerings. Chairman, Electrical Engineering Department, University of New Mexico, Albuquerque, New Mexico.

DEPARTMENT HEAD. Head professor for 12-man E. E. department. Excellent opportunity for energetic and progressive Ph.D. with experience and potential to build, administer, and participate in a balanced program of teaching, research, and extension. Box 145.

ELECTRICAL ENGINEER. Central Illinois utility has opening in substation design, transmission design and communications for engineer with a degree. Previous experience in these fields desirable. Salary up to $9,000. Send resume of education and experience to Box 146.

TRANSFORMER ENGINEER. With experience in the design and development of Hi-Frequency and Pulse Transformers for commercial and military applications. Ideal opportunity for ambitious man to develop full potential of present small department. Salary—open. Location—Erie, Penna. Call or send resume to: Chief Engineer, Erie Electronics Division, Erie Resistor Corporation, 645 West 12th Street, Erie, Penna., GL 6-8592.

IMMEDIATE OPENING FOR STAFF ENGINEER. Position with International Electrical Trade Association located in Midwest. Work entails minor electric motor design, writing of short articles, public speaking, approximately 15% travel and general consulting for repair of electric motors and generators. Prefer experienced man with degree in electrical engineering. Salary open. Send resume to: Box 150.

UTILITIES ENGINEER. The City of Lakeland, Florida, Department of Electric and Water Utilities, is accepting applications for position of Utilities Engineer. Applicants must have degree in electrical engineering; registered or capable of being registered in State of Florida. At least five years experience in supervisory or technical staff responsibilities in private or public utility plant. At least ten years experience in engineering capacities of design and programming nature. Excellent opportunity. Excellent opportunity. Salary $10,000 to $12,000. Retirement, leave and insurance benefits. Contact Emory E. Walker, Personnel Director, Civil Service Office, City Hall, Lakeland, Florida, or C. D. McIntosh, Jr., Director of Department of Electric and Water Utilities, City Hall, Lakeland, Florida.

INDUSTRIAL ENGINEER. The City of Lakeland, Florida, Department of Electric and Water Utilities, is accepting applications for position of Industrial Engineer. Applicants must have degree in mechanical, electrical or industrial engineering with at least five years supervisory or staff experience in public or private utility plant. Approximately ten years experience in various phases of industrial engineering. Excellent opportunity. Salary $10,000 to $12,000. Retirement, leave and insurance benefits. Contact Emory E. Walker, Personnel Director, Civil Service Office, City Hall, Lakeland, Florida, or C. D. McIntosh, Jr., Director of Department of Electric and Water Utilities, City Hall, Lakeland, Florida.

ELECTRICAL ENGINEER FOR DESIGN of rotating electrical machinery with experience on AC and/or DC motors and generators. Knowledge of regulators and electronics desirable. Send resume of education and experience to Personnel Department, Electric Specialty Company, 211 South Street, Stamford, Connecticut.

POSITIONS WANTED

ENGINEERING POSITION IN EUROPE. Electrical Engineer, age 39, ten years' experience in development, application, sales and service of control equipment application, sales and service of control equipment in U. S., plus five years' in Europe, fluent German, French. Wide acquaintance with European industry. Salary open. Box 149.

M.S.E.E., 38, 12 years design, test and development experience in rotating machine field, including D.C., synchronous and induction machinery, P.M. generators, 400 cy. Power Supplies, single and polyphase, etc. Supervising experience and ability, fluent German. Box 151.

YOUNG EXECUTIVE E. E. Chief of Engineering, R&D, in Electro-Mechanical Control Fields plus Sales, Manufacturing, Management & Foreign seeks growth position HOME or OVERSEAS. Box 152.

SENIOR ELECTRICAL ENGINEER, 43, BEE, 15 years diversified experience, domestic and foreign, planning, design and studies of transmission, substation, distribution and utilization systems. Desires foreign assignment with family. Available for interview New York, January 1962. Box No. 153.

SYMPOSIUM on ELECTRICAL PROPERTIES of SEMICONDUCTORS and the TRANSISTOR

A series of four articles, compilations of papers originally presented at a symposium on electrical properties of semiconductors and the transistor, held during the AIEE Summer General Meeting, Swampscott, Mass., June 1949. Sponsored by the Subcommittee on Electrical Properties of Solids and Liquids of the AIEE Committee on Basic Sciences.

It is hoped that this pamphlet (S-36, January 1950) will prove useful not only to the practicing engineer and teacher, but also to engineering students as an introduction to this field of electrical engineering.

Price is $0.50 ($0.25 to AIEE members). Send orders to: Order Department, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 345 E. 47th St., New York, N.Y.

Completely Revised, October 1956 Issue

Electric Power Distribution for Industrial Plants

(RED BOOK)

No. 952

The purpose of this publication is to bring to the attention of engineers, owners, and plant management the important features of well-designed electric distribution systems that result in satisfactory performance of utilization equipment and efficient operation of the plant; it covers the features of the electric distribution systems which are applicable to most types and sizes of industrial plants. It sets forth the elements of the distribution system both as to what to do to accomplish desired results and the reasons for them. It does not explain in detail how to accomplish the final results.

Basic information is included to determine the approximate load requirements of industrial plants, the type of distribution system, the distribution voltages, and voltage regulation, as well as information to assist the engineer in the selection of transformers, circuit breakers, relays, meters, fuses, cables, bus, and miscellaneous equipment needed in the design of an adequate electric distribution system for present and future load conditions. Operating and maintenance problems are dealt with only in so far as they affect system and equipment selection. Basic information is included to determine load requirements, type of system, and voltages. Data are included to assist selecting transformers, circuit breakers, relays, meters, fuses, conductor, and miscellaneous equipment for present and future loads.

$6.00 per copy (50 per cent discount to AIEE members); 172 pages

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Companion Publication (Also October 1956)

Grounding of Industrial Power Systems

No. 953

This publication covers the problems of system grounding, connecting the frames and enclosures of electric apparatus to a ground system, the problems of static, the methods of protecting structures against the effects of lightning, and the problems of obtaining a low resistance connection to the earth.

The popular name "Green Book" now applies to this new publication rather than to Interior Wiring Design for Commercial Buildings as before. The latter publication is out of print pending revision and when the new edition is available it will be known as the "Gray Book."

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SPECIFICATIONS

Display: 8 digits intermittent; 4 digits continuous readout (previous count displayed continuously during counting interval; changes to new value when count is completed).

Measurement Ranges:
Frequency: dc to 10 Mc
Period: 10μsec to 10^7 sec
Time Interval: 1μsec to 10^7 sec
Also measures 10 periods, frequency ratios, phase shifts, pulse characteristics, and counts random events.

Sensitivity: 0.25v rms

Accuracy: ± 1 count $\pm$ time-base stability. A variety of time-base generators are available with short-term stabilities ranging from 1 part in 10^8/min to 1 part in 10^9/min.

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**As of August 3, 1961*

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